

The American Midland Naturalist

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that of the Prairie States

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A REVIEW OF THE GENUS *lichenocrinus* AND DESCRIPTIONS OF TWO NEW GENERA.¹

CHARLES L. FABER.

I. INTRODUCTION AND ACKNOWLEDGMENTS.

Since 1886, when Hall defined the genus *Lichenocrinus*, several species have been described but no comprehensive study of the genus has been made. The purposes of this paper are to discuss the structure, to review most of the described species and to describe new forms of the genus *Lichenocrinus* and to define two new genera, *Xenobasis* and *Cystoidosaccus*.

The work is based on an examination of over two thousand specimens; more than half of these are in my own collection and the rest are in other collections and museums. Much of this material I myself have secured in the field but some of it was contributed by friends, whose services are acknowledged in the names of new species. Thanks are extended also to Mr. A. W. Slocum of the Walker Museum of the University of Chicago, Dr. C. A. Reeds of the American Museum of Natural History and Dr. R. S. Bassler of the U. S. National Museum, who have loaned types and other specimens for study. I have been assisted in the work by Mrs. Mildred Adams Fenton, who has searched the Miller Collection at the University of Cincinnati for types and other specimens

¹ Contributions from the University of Cincinnati Museum. Geology and Paleontology. Number 8.

and has made the photographs and prepared the plates illustrating this paper.

In giving the location of the type and other specimens considered in this paper the following abbreviations have been used both in the text and in the plate explanations, catalogue numbers preceding them:

A. M. N. H.—American Museum of Natural History.

C. L. F.—Collection of Charles L. Faber.

S. R. W.—Collection of S. R. Williams of Miami University.

U. C. M.—University of Cincinnati Museum.

W. H. S.—Collection of W. H. Shideler of Miami University.

W. M.—Walker Museum, University of Chicago.

II. METHODS OF STUDY.

There are numerous varieties or types of *Lichenocrinus* in formations from the Black River, through the Trenton, Cincinnati and Richmond and into the Fernvale. The number of forms or species is far greater than that described in this paper, which serves as an introduction to, rather than a summary of this complex group.

In considering *Lichenocrinus* various authors have held different concepts of species. We have, on the one hand, *L. pattersoni* Miller based on one specimen; and on the other, Meek's interpretation of *L. crateriformis* Hall which includes abundant specimens belonging to several distinct taxonomic groups that extend from the Eden through the Richmond. A comprehensive study, therefore, calls for some general concept of species as well as of characters on which they may be based.

This is difficult because *Lichenocrinus* is but one part of an organism, the part generally considered diagnostic, (the calyx), being unknown. The conclusions reached from the material at hand, therefore, are only approximate. The descriptions and names given to the forms are designed to aid in future study of the genus.

That the species designated may be as distinct as possible only the extreme or most clearly marked specimens have been selected. These give the major stages of variation or evolution into which minor stages or varieties later may be fitted.

In this study I have figured the most perfect specimen that could be found so that it will not be difficult for the eye to see the characters of the various species and in so far as possible, have selected specimens of equal size in showing the differences between related forms. This will be noted in the cases of *L. fentoniae*, *L. pattersoni* and *L. twitchelli* and in another group composed of *L. tuberculatus*, *L. nodosus* and *L. shideleri*, also in *L. dubius*, *L. stetteri* and *L. vaupeli*.

In determining species I have used all the characters exhibited by the forms. They are:

1. General appearance.
2. Condition of the crater.
3. Arrangement and ornamentation of plates:
 - a. Crater
 - b. Body
 - c. Rim.
4. Column, when present.

III. STRUCTURE OF LICHENOCRINUS— TERMINOLOGY

The organism represented by *Lichenocrinus* consisted of a calyx, a column and a basal body. Of the first we have no examples whose relationship to *Lichenocrinus* is assured. Though in 1898, G. Ashmann, A. Albers and I found a colony of *Lichenocrinus* in the Economy of Plaineville, Ohio. All specimens had columns, some three inches in length, attached to the bases. Three of the specimens were complete with calyx, column, and basal body. One of the calyces had three arms consisting of elongated plates; none of the arms showed bifurcation. These specimens were left in the care of Mr. Albers, an artist who at that time was engaged in illustrating some of my papers. Just before Mr. Albers' death these speci-

mens along with part of his collection disappeared. I hope that some day they will come to light. Even though these specimens cannot be found it seems desirable to record their discovery. There have been, however, quite a number of small calyces found associated with *Lichenocrinus*, but none of them have had enough of the column attached to show the characteristics peculiar to the *Lichenocrinus* column.

In the Austin Collection at the U. S. National Museum are three calyces originally associated in one slab with the basal bodies of *Lichenocrinus*.² These calyces retain so little of the column that the characters common to the known *Lichenocrinus* columns are not clear. Since the complete specimens in the Albers Collection are lost and the calyces of the Austin Collection cannot definitely be referred to *Lichenocrinus* no calyx of *Lichenocrinus* is known with certainty.

A. COLUMN

The columns of *Lichenocrinus* are perforated throughout; each columnal consists of five thin plates which form an alternating and interlocking system that extends about one and one-half inches above the basal body, beyond which it gradually changes to alternating and abutting and finally abutting only. The five plates of each columnal are distinctly marked throughout the length of all known columns. A pentagonal column with an abrupt change to a smaller pentagonal form has the alternating and interlocking system ending at the place of sudden change. Farther on it becomes semi-round and tapers toward the calyx. In a pentagonal column gradually becoming round and tapering, the alternating and interlocking system extends no more than one and one-half inches above the base. In the case of round columns, with no other change than tapering, the alternating and interlocking system also extends not more than one and one-half inches. These three forms have the plates of each columnal

² Dr. Bassler gave a short discussion of this material at the meeting of the Palaeontological Society in 1927. These specimens are described at some length in a paper by Mrs. Fenton. This issue, p. 491.

parallel and uniform in thickness. Another type of column is round and gradually tapering with plates of varying shape and thickness.

There are, therefore, four known types of *Lichenocrinus* columns, figured on Plates XXVII and XXX. Their characters may be briefly summarized as follows:

1. Pentagonal, changing abruptly to a smaller pentagonal form and finally becoming semi-round and tapering. This type is represented by *L. dubius*, *L. crateriformis* and an undetermined species from the Southgate.
2. Pentagonal, becoming round and tapering. This type is found in a form related to *L. crateriformis*.
3. Round and gradually tapering. This type of column is found in *L. dyeri* and undescribed forms from the Eden and the Elkhorn.
4. Round and gradually tapering with unequal plates. This type is represented by unattached columns from the McMicken.

B. BASAL BODY

The basal body, known as *Lichenocrinus*, is a more or less depressed convex disk attached to foreign objects. Its parts are given the following terms:

The floor plate, consisting of one piece, formed the attachment of the basal body to foreign objects. The *radial lamellae* rise vertically from the floor plate with which they are continuously united. As the floor plate grew in size peripherally, new lamellae were intercalated between the primary ones, thus forming the secondary series which does not reach the center. Between the lamellae are radial canals formed by them. In most forms the primary lamellae reach the center and form an elevation that is here termed the *node*. In highly convex specimens the lamellae are high, while in those with many body plates the lamellae are numerous.

The *node* is the central elevation beneath the column.

The *arch plate* rests on and covers the lamellae extending

peripherally as far as the floor plate. It seems to be of one piece and forms a support for the crater, body plates and superior rim plates. In some cases the outlines of the plates can be seen on the arch plate; the under surface so far as seen is smooth. In some cases there is below the arch plate a secondary calcareous deposit extending into and filling the radial canals. The arch plate so far has been observed in only *Lichenocrinus tuberculatus* and *L. nodosus*; it no doubt will be found in all species.

The *crater* is a depression surrounding the column. In some forms the crater is so small that if plates exist they cannot be seen, in others the crater is formed by one or two series of plates. In still others the crater is as large as half the diameter of the entire basal body and contains many series of plates; in such species the crater is flat. Where the basal body is highly convex, the crater is deep.

The *crater plates* form the depressed area around the column. They are smooth and thinner than body plates and range from a few to many in number. The way in which they were attached to the column is unknown.

Just beyond the crater plates are the *body plates*. In the more convex forms with high radial lamellae the body plates rest directly upon them or on the arch plate when it is present. There are three or more series of body plates and from a few to more than a thousand in each specimen. They may be of any size or shape and smooth or ornamented. The body plates increase in thickness toward the crater. The characters exhibited by these plates furnish the basis for specific distinctions.

Rim plates are the small plates at the margin of the basal body. There are from one to six series nearly always visible; on free specimens, however, one to three more rows of plates can be seen on the under surface. These plates are on a level with and attached to the floor plate though a slight break or demarcation can be seen between them. A series of specimens ranging from young to mature show that these rim plates are the last to have been added in the development of the

basal body, growth having taken place peripherally from the central region. In some forms the increasing age of the organism is accomplished by a marked decrease in the size of the newly added plates. The change from body to rim plates may be abrupt, in which case the latter are clearly demarked; if the change is gradual, the rim plates are of the same general appearance as the body plates and the demarcation is less distinct. Such a gradual change is found in forms with small body plates. In some species these newly added plates do not form a complete series, thus causing the periphery to become uneven.

IV. HABITS OF LIFE.

As has been said, *Lichenocrinus* is the basal portion of an at present unknown crinoid. Its function, like that of other bases, is to attach the organism either to the sea bottom, which frequently is composed of fragments of organisms, or some other firm anchorage. The common hosts are: bryozoans, brachiopods, and crinoid columns; such hosts will be seen in the illustrations. The less common hosts are pelecypods, trilobites and cephalopods; these may appear to be less common because from such smooth surfaces, or surfaces formed of aragonite, the *Lichenocrinus* are more quickly freed after their death or upon exposure to recent weathering. It is of interest to note that the basal surface or floor plate of the larger number of free specimens is relatively smooth, thus indicating that they are more easily freed from such surfaces as those of trilobites and cephalopods. One free specimen, however, (Plate XXVIII, Fig. 9), does bear the markings of its host, a *Strophomena*, while another, (Plate XXVIII, Fig. 11), bears faint markings of a *Pterinea*.

In their attachment, the *Lichenocrinus* bases show great power of adaptation to uneven surfaces. Not infrequently basal bodies are found entirely encircling slender bryozoans, (Plate XXIX, Figs. 3-4); others adhere to crinoid columns, (Plate XXIX, Fig. 2 and Plate XXXI, Fig. 2), their growth following the elevations and depressions of the columnals. A

specimen of *Lichenocrinus tuberculatus* Miller, (Plate XXVIII, Fig. 14), became subovate as its growth followed the side of the mesial fold of a *Platystrophia*.

In the specimens that I have collected and examined, I have never seen more than one species or variety attached to one host or small nodule; a nodule from the Southgate, (Plate XXIX, Fig. 1), has eleven distinct individuals of *Lichenocrinus* and evidence of four or five more, all of the same species.

Like many other forms in the Cincinnati, specimens of *Lichenocrinus* are frequently found in "pockets" or colonies. One such colony, containing approximately one thousand three hundred specimens, was found in the Elkhorn. Of the three hundred specimens, from it in my collection, all belong to *Lichenocrinus tuberculatus* Miller; each specimen, except for a few, is attached to an individual. Four sets of specimens, two with two organisms and one with three were crowded together. In this same colony are seven individuals, each bearing two distinct columns; two of these are shown on Plate XXIX, Fig. 6.

In another "pocket," in the Waynesville in a creek east of Pekin, Ohio, I found over three hundred specimens of *L. crateriformis* Hall associated with over six hundred specimens of *Reteocrinus nealli* (Hall). These specimens were on slabs and some individuals of *Lichenocrinus* were attached to the columns of *Reteocrinus*.

V. DESCRIPTIONS.

GENUS LICHENOCRINUS HALL.

Genotype *Lichenocrinus dyeri* Hall.

Lichenocrinus Hall, 20th Rept. N. Y. State Cab. Nat. Hist., (adv. sheets), p. 9, 1866; a reissue of the same, pl. 3, figs. 1-6. 1871.

Lichenocrinus Meek, Ann. Mag. Nat. Hist., 4th ser., vol. 8, p. 341. 1871.

- Lichenocrinus* Meek, Am. Journ. Sci. and Arts, 3d ser., vol. 2, p. 299. 1871.
- Lichenocrinus* Hall, 24th Ann. Rept. N. Y. State Mus. Nat. Hist., p. 216, pl. 7, figs. 1-7. 1872.
- Lichenocrinus* Meek, Ann. Mag. Nat. Hist., 4th ser., vol. 9, p. 247. 1872.
- Lichenocrinus* Meek, Am. Journ. Sci. and Arts, 3d ser., vol. 3, pp. 15 and 261. 1872.
- Lichenocrinus* Meek, Geol. Surv., Ohio, vol. 1, pt. 2, pp. 44-51. 1873.
- Lichenocrinus* Sardeson, Am. Geol., vol. 24, p. 275. 1899.
- Lichenocrinus* Bather, Treatise on Zool., pt. 3, Echinoderma, p. 77. 1900.

Description.—"Bodies parasitic on shells and other foreign substances. From discoid or depressed-convex, with a probosciform appendage rising from the center. Disc composed of an indefinite number of polygonal plates, and apparently having no distinct mode of arrangement. Proboscis perforate, and in the known species formed of five ranges of short plates alternating and interlocking at their margins." (Hall.)

Remarks.—When Hall wrote the above description of *Lichenocrinus* he evidently held the opinion that the column was homologous with the ventral tube of some crinoids. He later, however, considered the appendage a column. Meek, in 1871, suggests that the discs might be the peculiarly constructed basal attachment of a crinoid, whose calyx had not been associated with the column and base. From the material now at hand there seems to be no doubt that *Lichenocrinus* is a basal attachment of a crinoid.

No formal abbreviated definition is here given because the section on the structure of *Lichenocrinus* is essentially an elaborate description of the genus.

LICHENOCRINUS PATTERSONI MILLER.

Plate XXX, Fig. 6.

- Lichenocrinus pattersoni* Miller, Journ. Cincinnati Soc. Nat. Hist., vol. 2, p. 118, pl. 10, figs. 6-6a. 1879.

Description.—"Body robust, round or sub-circular, plano-convex, with a depression around the column, composed of numerous plates of unequal size, having no regular geometrical form, and disposed without any definite order of arrangement. If the plates, in the specimen illustrated, could be arranged, in regular concentric series, there would be, about eighteen ranges, between the column and the circumference.

"The plates are smooth.

"The column-like appendage is large, round and composed, as in other species, of five ranges of thin plates.

"The plates, in this species, are as large as the plates in *L. crateriformis*, and as numerous as in *L. dyeri*, but they have neither the arrangement nor form of either." (Miller.)

Dimensions of the holotype: diameter of the body 16 mm.; diameter of the crater 4 mm.; diameter of the column 3 mm.

Remarks.—*L. pattersoni* is a very distinct form and it need not be compared with any other species. The plates are flat and smooth, though if the specimen were not weathered they might appear granulose. Many of the plates are cuneiform and sharply angular; some of them, however, have slightly curved sides, a character peculiar to this species. The open character of the sutures is probably a result of weathering.

Occurrence.—The holotype was found in the Cynthiana in the river quarries of West Covington, Kentucky. It was associated with *Dendrocrinus dyeri* (Meek) and *Lingulops norwoodi* (James).

Holotype.—No. 8842, W. M.

LICHENOCRINUS FENTONAE N. SP.

Plate XXIX, Fig. 1; Plate XXX, Figs. 7-8.

Description.—Basal body is large, semi-circular and slightly convex. The semi-round column, each columnal of which is composed of five thin plates, occupies nearly the entire crater area; no crater plates can be distinguished. The body plates are numerous, slightly convex, granulose, irregularly

polygonal and generally radially elongate, though there are a few small plates scattered among the large ones. There are approximately ten circular series though the decrease in size of the plates toward the margin makes the circular arrangement less clear. The superior rim plates are distinguished from the body plates by their small size and peripheral position. The floor plate is very thin and bears distinct, though low, lamellae,

Dimensions of two cotypes, the one shown on Plate XXX, Fig. 7 and the other the right hand specimen shown on Plate XXX, Fig. 8: diameter of the body 13.9 and 19.4 mm.; diameter of the crater 4 and 5 mm.; diameter of the column c 3.3 and 3.4 mm.

Remarks.—There is evidence of the attachment of thirteen specimens of *L. fentonae* on the nodule. They are associated with crinoid bases and three specimens of *Hemicystites*. This species is named in honor of Mildred Adams Fenton who has prepared the plates illustrating this paper and has taken a deep interest in the study of *Lichenocrinus*.

Occurrence.—The locality of the cotypes is unknown but the association of specimens on the nodule indicates that they came from the Southgate.

Cotypes.—No. 10991, W. M.

LICHENOCRINUS TWITCHELLI N. SP.

Plate XXXI, Figs. 6-10.

Description.—Basal body subcircular in outline and slightly convex. A comparatively large pentagonal column occupies nearly the entire crater area; the crater plates are small and mainly obscured by the column. The body plates of the holotype, the largest specimen, are smooth, flat, irregularly polygonal and nearly uniform in size, though there is a slight decrease in size toward the periphery; there are about one thousand plates. The paratype shown on Plate XXXI, Fig. 7, the next largest specimen, has one to two series of convex plates around the crater and flat or convex plates to near the

margin where there are two series, or irregular groups, of small convex rim plates. The two other paratypes, the smallest of the specimens, have convex body plates with a tendency toward flatness and more distinctly convex rim plates. This would seem to indicate, therefore, that the convex body plates are characteristic of young individuals and as they matured the plates become flattened.

Dimensions of the holotype and the smallest paratype, shown on Plate XXXI, Figs. 9 and 7: diameter 15 and 4.5 mm.; diameter of the crater 4 and 1.8 mm.; diameter of the column 3 and 1.5 mm. (distorted).

The column of one paratype measures 20 mm., in this it tapers gradually. Each columnal is composed of five thin, alternating plates.

Remarks.—This species is named in honor of Dr. George B. Twitchell, who has assembled an interesting collection of Cincinnati bryozoans.

Occurrence.—Southgate; the holotype and two paratypes are from Rapid Run Creek, near Cincinnati, Ohio; the paratype, shown on Plate XXXI, Fig. 6, was found by Dr. W. H. Shideler in Muddy Creek, near Cincinnati, Ohio, and presented by him.

Holotype.—No. 10001; *Paratypes.*—Nos. 10002, 10003 and 10013, C. L. F.

LICHENOCRINUS DUBIUS MILLER.

Plate XXIX, Fig. 9; Plate XXX, Figs. 1-3.

Lichenocrinus dubius Miller, Journ. Cincinnati Soc. Nat. Hist., vol. 3, p. 234, pl. 7, figs. 5-5a. 1880.

Description.—"The head is robust and covered with conical elevations. The plates are more numerous than in *L. crateriformis*, and they are thrown into elevations and depressions on the surface, which, if not abnormal, will alone distinguish this from all other species.

"The column, in comparison with that of *L. crateriformis*, is short and thick. For a distance of one inch from the head,

the column is fluted-pentagonal, the depression being at the point of union of the interlocking pieces. At the distance of an inch from the head the column is abruptly contracted and changed to a plain pentagonal form. From this point the column gradually tapers and changes from the pentagonal to circular form, so that at the distance of one and one-fourth inches from the head of the column is round and smooth. Our specimen shows but little of the circular part of the column, but we may fairly infer from the tapering character of the column that the total length did not much exceed one and a half inches." (Miller.)

Basal body depressed convex with a comparatively large, flat center which is surrounded by an irregular ridge composed, in typical specimens, of isolated elevations, the outer slopes of which are abrupt. Crater plates small, flat and irregularly polygonal; they are numerous and have no definite arrangement. The body plates are smooth, irregularly polygonal and larger than the crater plates; they are arranged in three or four circular series. The superior rim plates, represented by one or part of a circular series, are like the body plates; their uneven growth causes the irregular outline of the body.

Dimensions of the right hand specimen shown on Plate XXX, Fig. 1 and the one shown in Fig. 2: diameter 10.7 and 9.6 mm.; diameter of the crater 5.7 and 6 mm.; diameter of the column 1.6 and — mm.

The column, though not complete, of Miller's type, Plate XXX, Fig. 3, is 30.6 mm. in length and 1.6 mm. in diameter. At a distance of 25 mm. from the base the pentagonal column changes abruptly in diameter and then gradually tapers. At the point of change the alternating arrangement of the plates gives way to the abutting system. A small portion of the column of the right hand specimen shown on Plate XXX, Fig. 1, (also Plate XXIX, Fig. 9), possesses the same character as does the column shown on Plate XXX, Fig. 3.

Remarks.—Though the specimen on which Miller based his species has the basal body poorly preserved and badly

distorted, the characters are sufficiently distinct to establish the form. In the Miller Collection at the University of Cincinnati a set of *L. dubius* was found, one specimen of which is figured on Plate XXX, Fig. 2, and is better preserved than the holotype.

Occurrence.—Fulton, Economy and Southgate.

Holotype.—No. 8783, W. M.; *Plesiotypes*.—Nos. 989, W. M., and 3875, U. C. M.

LICHENOCRINUS STETTERI N. SP.

Plate XXX, Figs. 4-5.

Description.—In general appearance this form is like *L. dubius* Miller; the large flat crater is surrounded by prominent isolated elevations. The crater plates are smooth and irregularly polygonal; those near the center are small while those nearest the elevations are large. The body plates are numerous, very irregular in size, shape and arrangement. On the outer slope are very irregular wide, short, convex plates that form depressions and the irregular outline of the body. The elevation to the right of the center of Fig. 5 has more than 60 plates. Dimensions of the holotype: diameter of the body 9 mm.; diameter of the crater 4-5 mm.; diameter of column 1 mm.

Remarks.—This species is named in honor of my friend, Fred M. Stetter, who has devoted more than forty years to collecting Cincinnati fossils and has given his collection to the University of Notre Dame.

Occurrence.—Southgate, Rapid Run Creek, near Cincinnati, Ohio.

Holotype.—No. 10007, C. L. F.

LICHENOCRINUS SCHLEMMERI N. SP.

Plate XXXI, Figs. 1-3.

Description.—Basal body subcircular in outline and slightly convex. The small crater area is almost filled by the pentagonal column; the crater plates are few and small. The body plates are flat, smooth, irregularly polygonal and about

as wide as long; they decrease in size toward the periphery where they merge with the superior rim plates. The latter are distinguished by their small size.

The dimensions of the holotype are: diameter of the body 9.5 mm.; diameter of the crater 2.5 mm.; diameter of the column 2 mm.

Remarks.—This species is named in honor of my friend Charles O. Schlemmer, a veteran collector of Cincinnati, who has given me many specimens of *Lichenocrinus*.

Occurrence.—Southgate, Rapid Run Creek, near Cincinnati, Ohio.

Holotype.—No. 10005; *Paratype.*—No. 10006, C. L. F.

LICHENOCRINUS VAUPELI N. SP.

Plate XXXI, Figs. 4-5.

Description.—Basal body depressed convex with a comparatively large crater composed of one series of elongate polygonal plates and a few irregular ones. The rounded-pentagonal column occupies a small part of the crater. The body plates are large, hexagonal to octagonal and decrease in size toward the periphery. The plates forming the first series surrounding the crater are ornamented by etched lines parallel to the margins and by a low rounded elevation in the center of each. The plates forming the remaining two to three series have the etched lines and a depression, instead of an elevation, in the center of each. The few distinguishable rim plates bear the same type of ornamentation as the body plates.

Dimensions of the holotype: diameter 7 mm.; diameter of the crater 2-3 mm.; diameter of the column 1 mm.

Remarks.—This species is named in honor of E. H. Vaupel who has given and loaned me many specimens of *Lichenocrinus* and with whom I have collected.

Occurrence.—Associated with the recurrent Fulton fauna of the Southgate, Rapid Run Creek near Cincinnati, Ohio.

Holotype.—No. 10004, C. L. F.

LICHENOCRINUS ASHMANNI N. SP.

Plate XXXIV, Figs. 5-6.

Description.—Basal body irregular in outline, marked by a high, angular subquadrangular ridge which is broken by concave depressions. The crater, bounded by the inner slope of the ridge, is wide and comparatively deep, the discoid base of the column occupying only a small portion of the area. The crater plates are smooth, flat, comparatively large and irregularly polygonal; 2 to 3 alternating series from the column to the ridge. Some of the crater plates join the body plates on the crest of the ridge and others form the crest, with portions sloping toward the crater and toward the margin. The body plates are polygonal, irregular in shape and arrangement.

The plates forming the ridge show low pointed elevations in the center or at the angles of the plates, one or two on a plate. Probably three plates on a radius from the ridge to the margin. Superior rim plates are not distinct though at the margin of the floor plate one or two series of inferior rim plates can be seen. The arched floor plate shows that it was attached to a highly convex surface. A part of a circular series of plates, shown on Plate XXXIV, Fig. 6, seems to be the inferior surface of the body plates forming the ridge around the crater.

Dimensions of the holotype: maximum diameter 10.7 mm.; diameter of the crater 5-6 mm.; diameter of base of column 1.5 mm.

Remarks.—The conspicuous angular ridge characterizing this species is not the result of distortion, as at first might be supposed. The circular series of plates, part of which is shown on Plate XXXIV, Fig. 6 represents the under side of the ridge; these plates are heavy and thick, and leave no doubt that the ridge is a result of normal growth.

This species is named in honor of my friend, the late George Ashmann, a collecting companion for over fifty years.

Occurrence.—Mt. Hope, near Elberon Avenue Heights, Price Hill, Cincinnati, Ohio.

Holotype.—No. 10016, C. L. F.

LICHENOCRINUS DYERI HALL.

Plate XXVII, Fig. 5; Plate XXXIV, Figs. 7-12.

Lichenocrinus dyeri Hall, 20th Rept. N. Y. State Cab. Nat. Hist. (adv. sheets) p: 9, 1866; a reissue of the same, pl. 3, figs. 1-6. 1871.

Lichenocrinus dyeri Hall, 24th Ann. Rept. N. Y. State Mus. Nat. Hist. p. 216, pl. 7, figs. 1-6. 1872.

Lichenocrinus dyeri Meek, Geol. Surv. Ohio, Pal., vol. 1, pt. 2 p. 51, pl. 3, figs. 2 (and 3a-3b). 1873.

For additional references see Bull. 92, U. S. N. M., p. 722.

Description.—"Body small, discoid, depressed in the middle, with five slight elevations midway between the center and the edge of the disc. Proboscis strong, composed of short plates. Disc composed of very small polygonal plates. Surface smooth." (Hall.)

Basal body convex, crater large and steep sided; crater plates small and probably arranged in two series. The large semi-round column occupies nearly the entire crater area and obscures the crater plates. Body plates, convex and granulose, quadrangular to hexagonal, though generally pentagonal and quite irregular in size and shape. Hall's type, (Plate XXXIV, Fig. 8), as well as a plesiotype, show elongate, slightly wedge shaped plates toward the margin. Five to seven plates can be counted along a radius from the crater to the margin. Rim plates have the same character as the body plates, differing only in their smaller size. The free specimen shown on Plate XXXIV, Fig. 9, has portions of the floor plate near the margin; the inferior surface of the body plates bear traces of the radiating lamellae, upon which they must have rested directly. The central portion of the specimen shows the lamellae with matrix filling the inter-spaces.

Dimensions of two plesiotypes shown on Plate XXXIV,

Figs. 11-12: diameter 10.8 and 6 mm.; diameter of the crater 4.2 and 2 mm.; diameter of the column 3.5 and 1.5 mm.

A characteristic column of this species is shown on Plate XXVII, Fig. 5. At the base it is about one-third the entire diameter of the basal body; it shows a gradual tapering even in the 35 mm. of column preserved. Five comparatively thin alternating hexagonal plates form each columnal; at a distance of 30 mm. from the base the plates become quadrangular but still alternate. This heavy type of column appears to be a specific character.

Remarks.—Hall's figure of *L. dyeri*, reproduced on Plate XXXIV, Fig. 7, shows a large number of rim plates; the specimen from which his drawing was made, Plate XXXIV, Fig. 8, does not show a large number of small plates near the margin.

Occurrence.—Corryville. The plesiotypes shown on Plate XXXIV, Figs. 9, 11 and 12 are from Fairview Heights, Cincinnati, Ohio. Another plesiotype, shown on Plate XXVII, Fig. 5, was found at the same place by E. H. Vaupel.

Holotype.—No. 1190, A. M. N. H.; *Plesiotypes.*—Nos. 10023, 10024, 10012, C. L. F., 33407, W. M. and 1390, U. C. M.

LICHENOCRINUS CRATERIFORMIS HALL.

Plate XXXII, Figs. 5-12.

Lichenocrinus crateriformis Hall, 20th Rept. N. Y. State Cab. Nat. Hist. (adv. sheets) p. 9, 1866; a reissue of the same, pl. 3, fig. 7. 1871.

Lichenocrinus crateriformis Hall, 24th Rept. N. Y. State Mus. Nat. Hist. p. 217, pl. 7, fig. 7. 1872.

Lichenocrinus crateriformis Meek, Geol. Surv. Ohio, Pal., vol. 1, pt. 2, p. 51, pl. 3, figs. 1a-1t (part). 1873.

Lichenocrinus affinis Miller, Journ. Cincinnati Soc. Nat. Hist., vol. 5, p. 229, pl. 9, figs. 7-7a. 1882.

Lichenocrinus affinis Foerste, Bull. Sci. Lab. Denison Univ., vol. 17, p. 478, pl. 2, fig. 5. 1914.

For additional reference see Bull. 92, U. S. N. M., p. 721.

Description.—Basal body small, depressed convex with a comparatively large crater; crater plates polygonal, somewhat irregular in size and arranged in one or two series. The small pentagonal column occupies about one-third the crater area. The body plates are flat or slightly convex, pentagonal and hexagonal, nearly uniform in size and arranged in alternating series; 2 to 3 plates can be counted along a radius from the crater to the margin. A few small plates are seen at the margin.

Dimensions of the holotype and Miller's type of *L. affinis* and the specimen shown on Plate XXXII, Fig. 9: diameter 5.5, 4.9 and 4.5 mm.; diameter of the crater of each 2 mm.; diameter of the column 0.8, 0.7 and 0.6 mm.

Remarks.—Some variation will be noted among the specimens figured on Plate XXXII, Figs. 5-12. The body plates of Miller's *L. affinis* are somewhat larger than those in the holotype or in either of the two specimens represented by Figs. 7 and 9. Such variations in the size of plates are considered individual, since these specimens agree in all other respects. Similarly the crater plates shown by Fig. 7 are somewhat more irregular in size and are on the whole smaller than those shown by Fig. 6; they are, however, comparable to those seen in Fig. 9.

The horizon of *L. crateriformis* generally has been considered to be the Eden, though Hall states that his type was found at Oxford, Ohio, and the specimen, (Plate XXXII, Fig. 12), is attached to a pedicle valve of *Strophomena planumbona* Hall, thus fixing its horizon as either Waynesville or Liberty. Meek states that this species "ranges through most of the thickness of the Cincinnati group at that place, [Cincinnati], and for fifty or more miles from there in the surrounding country." Bassler in his "Bibliographic Index of American Ordovician and Silurian Fossils" gives the horizon of *L. crateriformis* as Eden.

Meek, in addition to figuring what appear to be typical specimens of *L. crateriformis*, illustrates several specimens

that will probably be found to belong to other forms. One of his plesiotypes has the plates so poorly preserved that identification is uncertain; the column, however, is very well preserved and is here figured, (Plate XXVII, Figs. 7-8), to show its character.

Foerste, in 1914, refigured but did not discuss the two cotypes of *Lichenocrinus affinis* illustrated on Plate XI, Fig. 7, accompanying Miller's original description. These specimens, part of a larger set, are now lost; but Foerste's figures show that they possessed the character of the other extant cotypes, such as the ones illustrated on Plate XXXII, Figs. 5-6, of the present paper. They differ, however, from the enlarged drawing published by Miller, (Plate XI, Fig. 7), which, rather than the actual specimens, appears to be the basis of his description, in having a larger column, larger and more flattened crater and fewer, larger and more regular plates. In all of these characters they conform to the holotype of *L. crateriformis* Hall, of which *L. affinis* Miller, therefore, must be considered a synonym.

Forms that resemble *L. crateriformis* and are allied to it are found in all formations from the Mt. Auburn down through the Eden, the Fulton and even in the Trenton, the most primitive ones appearing in the Decorah, (Black River), of the Mississippi Valley. There are, therefore, many related forms of *L. crateriformis* and they differ from each other according to the formations in which they occur. Many of these I have both from the Cincinnati and older formations, but in this paper I am not undertaking to describe or figure them, preferring to wait until more material with accurate data has been obtained.

Occurrence.—From the Waynesville to the Elkhorn. Hall's type is from the Waynesville or Liberty at Oxford, Ohio; Miller's types of *L. affinis* are from the Waynesville near Lebanon, Ohio. The specimens shown on Plate XXXII, Figs. 7-8 are from the Waynesville near Pekin, Ohio, and the specimen

represented by Fig. 9 was found by W. H. Shideler in the Elkhorn near Hamburg, Indiana.

Holotype.—No. 1190 a, A. M. N. H.; *Plesiotypes*.—Nos. 8810, W. M., 10044, 10045 C. L. F., and specimen in collection of W. H. Shideler.

LICHENOCRINUS IRREGULARIS N. SP.

Plate XXXII, Fig. 13.

Description.—This form is closely related to *L. crateriformis* Hall but is distinguished from it by the irregularity of the size, shape and arrangement of the body plates. They range from quadrangular to hexagonal and are arranged in approximately five or six series. The crater is large and deep and is less flattened in the center than is characteristic of *L. crateriformis*; crater plates are of the same type as the body plates and would be arranged in two series. It seems that the column may have had a greater diameter than that of *L. crateriformis*.

Dimensions of the holotype: diameter 5 mm.; diameter of the crater 2 mm.

Occurrence.—Whitewater, Dodge Creek, near Oxford, Ohio.

Holotype.—No. 10046, C. L. F.

LICHENOCRINUS KEMPERI N. SP.

Plate XXXII, Figs. 1-4.

Description.—Basal body highly convex with a deep, steep-sided crater composed of two series of small, smooth plates. The pentagonal column occupies only a small portion of the crater area. The body plates are smooth, flat and meet each other to form a regularly convex surface; they are uniform in size and characteristically hexagonal. There are five to six series of body plates, the rim plates being indistinguishable from them.

Dimensions of the two types: diameter 9 mm. each; height 3 and 2.5 mm.; diameter of the crater 3.5-4 and 2.5 mm.; column — and 1 mm.

Remarks.—The regular, high convexity and the deep crater of *L. kemperi* form a group of characters found in other species of *Lichenocrinus* in my collection, and ranging through the Economy, Southgate and Waynesville. In these respects, however, these species differ strikingly from *L. kemperi*.

This species is named in honor of my friend, Willis M. Kemper, who has collected Cincinnati fossils for many years.

Occurrence.—Elkhorn, about seven feet above the strata bearing *L. tuberculatus* Miller and *L. milleri* n. sp. The types were found in Seven Mile Creek, two and one-half miles south of Eaton, Ohio. The specimen shown on Plate XXXII, Fig. 1, was found by Dr. W. H. Shideler and presented to me.

Holotype.—No. 10040; *Paratype.*—No. 10041, C. L. F.

LICHENOCRINUS TUBERCULATUS MILLER.

Plate XXXIII, Figs. 1-2.

Lichenocrinus tuberculatus Miller, Cincinnati Quart. Journ. Sci., vol. 1, p. 346, fig. 38. 1874.

Lichenocrinus tuberculatus Miller, Journ. Cincinnati Soc. Nat. Hist., vol. 5, p. 229, pl. 9, figs. 6-6a. 1882.

Description.—"Body discoidal, circular in outline; lower surface or surface of attachment, flat, or conforming to the surface to which it is attached; upper surface strongly convex or subhemispheric, with a deep circular depression in the central part, around the column; upper surface of body composed of numerous, irregularly arranged, thin, pentagonal or hexagonal plates, nearly uniform in size, smooth on the under side and highly convex or tuberculated on the outer surface. Excluding the plates immediately surrounding the column, within the central depression, which are much smaller than the others, the remainder will number about one hundred. Interior filled with upright lamelliform plates, radiating from a central point, on which the exterior plates appear to repose. Column pentagonal, length unknown.

.....

"It is distinguished from *L. crateriformis*, which species it most resembles, by its tuberculated plates. It differs, too, in its greater convexity, more abrupt central depression, and greater uniformity in the size of its plates.

"..... Small specimens, very closely resembling this species in general outline, are found near Clarksville, in Clinton county, Ohio, but differing, in the specimens examined, in this important regard, that the plates appear to be smooth instead of tuberculated." (Miller.)

Basal body, usually highly convex, crater comparatively small and shallow to moderately deep. Crater plates, smooth, flat, polygonal, irregular in size and shape; they are arranged in two series, the one nearest the column being composed of smaller plates than the other. The pentagonal column, occupying about half the entire crater area, is composed of thin alternating plates, five of which form a columnal. The body plates are numerous, 5-6 in the space of 3 mm. in Miller's type and 6-7 in the space of 5 mm. in the plesiotype figured on Plate XXXIII, Fig. 1, the latter being the larger of the two specimens. In individual specimens they are nearly uniform in size from the crater to the margin and range from quadrangular to octagonal, though generally from pentagonal to hexagonal; five to six plates can be counted along a radius from the crater to the margin. The plates bear low rounded to high conical tubercles, in some cases surrounded by incised lines parallel to the margins of the plates. Miller's cotype, a free specimen, has two series of rim plates; the arch plate is revealed near the margin where several body plates are removed. The arch plate is best shown on Plate XXVIII, Figs. 1-2.

The dimensions of Miller's type and the plesiotype figured on Plate XXXIII, Fig. 1: diameter 6.4 and 9.4 mm.; diameter of the crater 1.9 and 2.5 mm.; diameter of the column 1 and 1.5 mm.

Remarks.—In Miller's set of cotypes of *L. tuberculatus* were specimens belonging to the new forms of *L. milleri* and

L. shideleri; his plesiotype is here considered under *L. nodosus*. Miller apparently did not make the distinction between the three types of tuberculated plates, though such separation seems desirable.

Occurrence.—Waynesville to Elkhorn. Miller's cotypes and the plesiotype figured on Plate XXVIII, Fig. 1, are from Hill's Mills, near Richmond, Indiana; plesiotypes figured on Plate XXVIII, Fig. 14 and Plate XXXIII, Fig. 1 were found near Richmond, Indiana; an unfigured plesiotype is from Seven Mile Creek, near Eaton, Ohio.

Cotypes.—Nos. 3877, 3978 and 3983, U. C. M.; *Plesiotypes*.—Nos. 10014, 10050, C. L. F. and 21034, W. M.

Except those mentioned in the preceding paragraph, Miller's cotypes of *L. tuberculatus* have been found to belong to other forms: Nos. 3878 and 1388, U. C. M., to *L. milleri*; 1387, U. C. M., to *L. shideleri regularis*. Miller's plesiotype No. 8826, W. M., is a paratype of *L. nodosus*.

LICHENOCRINUS MILLERI N. SP.

Plate XXXIII, Figs. 3-9.

Description.—Basal body depressed convex; crater characteristically large and deep and covered by smooth, thick quadrangular to hexagonal plates of which there probably are two series between the body plates and the column. The pentagonal column occupies about half of the crater area. The body plates are thick pentagonal to octagonal with occasional small quadrangular ones. There are 3-4 plates in the space of 5 mm. and 3-4 may be counted along a radius from the crater to rim plates. These plates are ornamented by incised lines paralleling the margins and a high rounded or angular tubercle in the center. The outline of the body varies according to the addition of the rim plates of which there may be one series or irregularly arranged groups; the upper left hand margin of Fig. 3, Plate XXXIII shows such a group. Not infrequently these most recently added plates bear highly angular or rounded tubercles. Free specimens show floor plates and 1 to 2 series of inferior rim plates.

Dimensions of the holotype and the paratype No. 10030: diameter 14.7 and 12 mm.; diameter of the crater 4 and 3.7 mm.; diameter of the column 2.3 and — m.

Remarks.—This form is closely related to *L. tuberculatus* but is distinguished from it by the large, highly tuberculated body plates and the numerous irregularly arranged rim plates. One of Miller's cotypes of *L. tuberculatus* is here figured as a paratype of *L. milleri*. The two forms of *L. tuberculatus* and *L. milleri* are very closely related and may possibly intergrade; at one locality, Seven Mile Creek, near Eaton, Ohio, they are associated in the same strata with *Lepadocystis moori* (Meek). This species is named in honor of S. A. Miller.

Occurrence.—Elkhorn. The holotype was found near Versailles, Indiana; the paratype shown on Plate XXXIII, Fig. 6 was found at Lytle, near Lebanon, Ohio; the specimen shown in Fig. 7 was found three miles south of Osgood, Indiana, and the one in Fig. 8, at Hill's Mills, near Richmond, Indiana.

Holotype.—No. 10029; *Paratypes.*—Nos. 10021, 10030, 10047, C. L. F. and 3878, U. C. M.

LICHENOCRINUS NODOSUS N. SP.

Plate XXXIII, Figs. 10-12.

Description.—Depressed convex with a large crater, only a small portion of which is occupied by the pentagonal column. The crater plates are elongate, generally smooth, pentagonal to heptagonal and arranged in one series; two of the partypes have 9 and 12 respectively. Distally the crater plates become broader than at the base of the crater and alternate with the nodose body plates; this arrangement is well shown on Plate XXXIII, Fig. 12; most of the crater plates are lost in the holotype. The body plates are arranged in 2 to 4 alternating series; those forming the first series are pentagonal and hexagonal with one node or tubercle rising from the margin of each plate. Those of the outer series are elongate, irregular in size and outline and convex or tuberculate; these plates are well shown by the figures. The lamellae

are highly arched and the body plates rest directly on them.

Dimensions of the holotype and largest paratype: diameter 8.5 and 11.3 mm.; diameter of the crater 4 and 4.6 mm.; diameter of the column — and 1 mm.; maximum height 2.3 and 2.9 mm.

Remarks.—The group of three specimens, here figured as paratypes, were used by Miller in his redescription of *L. tuberculatus*; they possess the elongate crater plates and elongate marginal plates which characterize *L. nodosus*.

Occurrence.—Waynesville to Elkhorn; the holotype is from the Waynesville near Weisburg and the paratypes are from the Elkhorn, three miles south of Osgood, Indiana.

Holotype.—No. 10032, C. L. F.; *Paratypes.*—No. 8826, W. M.

lichenocrinus shideleri N. SP.

Plate XXVIII, Fig. 9; Plate XXXIV, Figs. 3-4.

Description.—Basal body irregular in outline and very slightly convex; crater deep in proportion to the total height of the specimen. Pentagonal column occupies about half of the crater area; the crater plates appear to be of the same character as the body plates and arranged in one series. Body plates quadrangular to octagonal, angles slightly rounded, irregular in size and with no definite arrangement. Small plates, usually quadrangular, appear irregularly between the larger body plates. The body plates are highly convex or tuberculated, incised lines paralleling the margins mark a few of the plates, particularly in the paratype; incised concentric lines ornament some of the tuberculated plates. The holotype has 7 plates in the space of 5 mm. while the paratype has from 6 to 8 in the same space. Five to 7 plates can be counted along a radius from the crater to the margin. The body plates are the same to the margin except that the most recently added are smaller than the others.

The floor plates of the types, free specimens, are either smooth or bear the markings of the host.

The dimensions of the holotype and the paratype: diam-

eter 10.5 and 10.3 mm.; diameter of the crater 3.6 and c 4 mm.; diameter of the column 1.9 and — mm.; height including the floor plate 2.2 and 2.6 mm.

Remarks.—This form is closely related to *L. tuberculatus* from which it differs in being less convex and more irregular in outline. The body plates of *L. shideleri* are less angular, more irregular in size, and their tubercles are more conical than those of *L. tuberculatus*.

This species is named in honor of Dr. W. H. Shideler of Miami University who found and presented the types, as well as the specimen shown on Plate XXVIII, Fig. 4, which is probably *L. shideleri*.

Occurrence.—Saluda, near Mixerville, Indiana; it occurs also in the Elkhorn.

Holotype.—No. 10026; *Paratype.*—No. 10028, C. L. F.

LICHENOCRINUS SHIDELERI REGULARIS N. VAR.

Plate XXVIII, Fig. 8; Plate XXXIV, Figs. 1-2.

Description.—Basal body depressed, slightly convex; crater large and deep in proportion to the convexity, the pentagonal column occupying about half the area. The crater plates appear to be smaller than, but of the same character as, the body plates; they are probably arranged in two series, matrix covers most of the plates in the holotype. The body plates are quadrangular to octagonal, quite regular in size though a very few small plates are found between the large ones. The plates are not sharply angular and are convex to tuberculate though the tubercles are low and rounded. Incised circular lines mark some of the plates. Three to 6 plates can be counted along a radius from the crater to the margin. Rim plates are small and convex; they are irregularly arranged in one or two series or grouped together. One series of inferior rim plates can be seen on free specimens; these small plates are in one continuous series or alternate with the next series of slightly larger plates. The holotype is free and the floor plate, shown on Plate XXVIII, Fig. 8, is comparatively smooth.

Remarks.—This form differs from *L. shideleri* in having larger and more regular plates with lower and less conical tubercles. With this variety is also considered, though not in the above description, the specimen shown on Plate XXXIV, Fig. 2. This individual is larger than the holotype with flatter plates, marked by incised lines, in a depression surrounding the normal crater area.

Occurrence.—Elkhorn; the holotype is from near Richmond, Indiana, and the paratype is from south of Osgood, Indiana.

Holotype.—No. 10027; *Paratype.*—No. 10025, C. L. F.

GENUS XENOBASIS NOV.

Genotype: *Xenobasis williamsi* n. sp.

Description.—Basal body suggests *Lichenocrinus* in general shape. Column large, round or subpentagonal composed of thin abutting plates, five to each columnal. Body plates numerous, polygonal or subpolygonal; they decrease in size toward the margins, though large plates do occur far from the crater. Between the body plates are small, subpolygonal plates whose distribution in the genotype is described under that species.

Remarks.—The basal body of *X. williamsi* bears some resemblance to that of *Cleiocrinus grandis* Billings, (Canadian Organic Remains, decade 4, p. 54, pl. 5, figs. 2a-c, 1859). The growth of columns in that species, however, resembles that of *Anomlocrinus* and some other crinoids whose bases are found in Cincinnati strata. The column of *Cleiocrinus* is markedly pentagonal and contains a very large, round canal, quite unlike that in *X. williamsi* nor does the base of *Cleiocrinus* possess the rows of minute plates which characterize the present genus.

XENOBASIS WILLIAMSI N. SP.

Plate XXXV, Figs. 1-3.

Description.—Basal body robust, convex, irregular in outline, with lobate extensions marginally. Crater large and

steep-sided; the crater plates are small but are mainly hidden by the large, semi-round column which occupies nearly the entire area. The surface of the column is ornamented by small nodes, 7 to 8 of which occupy the space of 2 mm. Body plates smooth, flat, irregularly polygonal, large to small; 12 to 16 may be counted along a radius. Between the larger body plates are rows of minute, subpolygonal plates; marginally these rows become broken, and isolated minute plates may be found.

Dimensions of the holotype: maximum radius, (from center of column), 14.5 mm.; diameter of crater 7 mm.; diameter of column 5.7 mm.

Remarks.—This specimen is attached to the irregular surface of a rock formed of fragments of bryozoans, crinoid columns, brachiopods and matrix.

This species is named in honor of S. R. Williams of Miami University by whom the holotype was found.

Occurrence.—Liberty, Dodge Creek, near Oxford, Ohio.

Holotype.—Collection of S. R. Williams.

GENUS CYSTOIDOSACCUS NOV.

Genotype: *Cystoidosaccus fultoni* n. sp.

Description.—Basal body resembles *Lichenocrinus* in general shape but is larger, less regular in outline and strongly lobate. Crater plates small; body plates small to large, irregularly and variably polygonal, without definite arrangement.

The distinctive character of the genus is a large opening which, in the genotype, is situated eccentrically, near the margin; about it is a depressed, flattened area paved with plates smaller than the body plates but variable in size. The opening itself, in the one specimen known, is diamond-shaped and quadrangular bounded by ridges composed, so far as can be seen, of two rows of small plates; outwardly, the ridges are continuous with the surface of the depressed area.

CYSTOIDOSACCUS FULTONI N. SP.

Plate XXXV, Figs. 4-5.

Description.—Basal body large, irregularly convex, lobate. Column robust, subpentagonal, occupying most of the crater area. Crater plates smaller than the body plates, but not otherwise distinguished from them. Body plates numerous, small to large, irregularly polygonal, pentagons and hexagons being the most common; their surfaces are depressed convex. There is no definite pattern of plate arrangement, though something resembling the rosette of plates in the right-hand lobe, (Plate XXXV, Fig. 4), may be seen on other parts of the body.

The general characters of the diamond-shaped opening have been mentioned in the description of the genus. The plates composing the depressed area are variable in size, those at either end being nearly as large as the adjoining body plate, while those above and below it are very small. The ridges immediately bounding the opening also are composed of two rows of small plates, generally hexagonal, which merge outwardly with those of the depressed area. At the upper and lower angles of the opening a deep groove separates the adjoining ridges.

Dimensions of the holotype: maximum diameter 22 mm.; maximum diameter of crater 7 mm.; diameter of column c 5 mm.

Remarks.—The holotype is attached to the uneven surface of a specimen of *Stromatocerium huronense* (Billings). The column was in place when the specimen was found; it was large, subpentagonal and resembled the typical columns of *Lichenocrinus*. During the removal from the rock, however, the column was lost, so that no detailed description of it can be given.

The species is named in honor of my friend, Robert S. Fulton, whose collection is preserved in Western College at Oxford, Ohio.

Occurrence.—Tetradium—*Stromatocerium* reef of the Up-

per Elkhorn, Elkhorn Creek, Indiana, in N E one-fourth,
Sec. 29, T. 13 N., R. 1 W. (Foerste's locality No. 8.)

Holotype.—No. 10042, C. L. F.

EXPLANATION OF PLATES.

NOTE.

Unless otherwise stated, the figures are magnified two diameters; all other magnifications or reductions are also indicated in terms of diameters. The abbreviations used in the plate explanations are the same as those used in the text and will be found on page 454.

PLATE XXVII.

FIGURE	PAGE
1. Unattached column from the McMicken member.....	457
A specimen representing the round type of column composed of unequal plates. (10008 C. L. F.)	
2—3. Unattached columns from the McMicken member.....	457
These represent the round and gradually tapering type of column. (10009 and 10010 C. L. F.)	
4. Undescribed form from the Southgate member.....	457
This figure shows an abrupt change in the size of the pentagonal column, beyond which it gradually becomes round. (10011 C. L. F.)	
5. <i>Lichenocrinus dyeri</i> Hall.....	457
This specimen shows a heavy round column gradually tapering. (10012 C. L. F.)	
6. Undescribed form from the Southgate.....	457
A specimen with a pentagonal column gradually becoming round. (9573 W. M.)	
7—8. <i>Lichenocrinus</i> sp. from the Eden.....	457
7. Meek's plesiotype of <i>L. crateriformis</i> Hall. This specimen is attached to a <i>Dalmanella</i> ; it has a pentagonal column gradually becoming round. (986 W. M.) $\times 1$.	
8. Portion of the same enlarged. $\times 2$.	

PLATE XXVIII.

FIGURE	PAGE
1—3. <i>Lichenocrinus tuberculatus</i> Miller.....	457
1. A weathered specimen with some of body plates removed showing the arch plate. (10014 C. L. F.)	
2. The same enlarged. Outlines of some of the body plates can be seen on the arch plate. The peripheral edge of the arch and floor plates can also be seen. x 5.	
3. Unattached specimen showing a relatively smooth floor plate and a portion of the lower surface of the arch plate, (at the right side of the figure.) (10015 C. L. F.)	
4. <i>Lichenocrinus</i> cf. <i>shideleri</i> n. sp.....	457
Four individuals crowded together, showing the primary and secondary lamellae and the nodes. Elkhorn, Osgood Pike, one mile from Versailles, Indiana. (10049 C. L. F.)	
5. <i>Lichenocrinus</i> sp.	457
This has fewer primary and secondary lamellae than the specimen shown in Fig. 4. Waynesville, near Weisburg, Indiana. (10018 C. L. F.)	
6. <i>Lichenocrinus tuberculatus</i> Miller.....	457
This shows many primary and secondary lamellae with traces of the former upon the node. Elkhorn, two and one-half miles south of Eaton, Ohio. (10019 C. L. F.)	
7. <i>Lichenocrinus</i> sp.	457
This specimen has rather heavy lamellae and, therefore, not as many as are shown by Fig. 6. Waynesville, near Pekin, Ohio. (10017 C. L. F.)	
8. <i>Lichenocrinus shideleri regularis</i> n. sp.....	457
Unattached specimen showing a smooth floor plate with a distinct demarcation between it and the inferior rim plates. Top view shown on Plate XXXIV, Fig. 1. (10027 C. L. F.) x 1.25.	
9. <i>Lichenocrinus shideleri</i> n. sp.....	459
This figure shows a floor plate bearing the markings of its host, a <i>Strophomena</i> . Inferior rim plates can be seen as well as the eccentric node. Top view on Plate XXXIV, Fig. 4. (10026 C. L. F.)	
10—11. <i>Lichenocrinus tuberculatus</i> Miller.....	459
The regular ring of plates near the margin represents one stage in the growth of this individual. The rim plates extend from this ring to the floor plate. Elkhorn, near Lytle, Ohio. (10020 C. L. F.)	

FIGURE	PAGE
11. Under surface of the same showing the floor plate bearing markings of its host, a <i>Pterinea</i> .	
12—13. <i>Lichenocrinus</i> sp.	459
12. Thirty-two young individuals attached to a bryozoan; a few specimens have distinguishable body plates but specific characters are not developed at such an early stage. Waynesville, near Pekin, Ohio. (10022 C. L. F.) x 1.	
13. Nineteen young specimens attached to <i>Strophomena nutans</i> Meek. A few have distinguishable plates. Liberty, Four Mile Creek, near Oxford, Ohio; found and presented by Dr. W. H. Shideler. (10043 C. L. F.)	
14. <i>Lichenocrinus tuberculatus</i> Miller.....	460
This shows a specimen conforming to the surface of its host. The <i>L. tuberculatus</i> has its greatest diameter parallel to the fold of the <i>Platystrophia</i> . (21034 W. M.)	

PLATE XXIX.

FIGURE	PAGE
1. <i>Lichenocrinus fentonae</i> n. sp.	460
Thirteen individuals of <i>L. fentonae</i> crowded together on a nodule; associated with them are several crinoid bases and specimens of <i>Hemicystites</i> . (10991 W. M.) x .6.	
2. <i>Lichenocrinus dubius</i> Miller.....	459
This shows a specimen attached to and encircling a crinoid column. (10037 C. L. F.)	
3—4. <i>Lichenocrinus tuberculatus</i> Miller.....	459
These specimens have grown around the slender zooaria of <i>Bythopora delicatula</i> (Nicholson). (10035, 10036 C. L. F.)	
5. <i>Lichenocrinus</i> sp.	457
This specimen has its floor plate folded as though it had grown over the edge of a very delicate host, no trace of which is preserved. (10038 C. L. F.)	
6—8. <i>Lichenocrinus tuberculatus</i> Miller.....	460
6. Two abnormal individuals with two columns and two craters each. (10034 C. L. F.)	

FIGURE	PAGE
7. Top view showing the apparently eccentric position of the column; the outlines of the plates are slightly obscured by <i>Corynotrypa inflata</i> (Hall). (10039 C.L.F.)	
8. Same specimen showing the large number of small plates on the portion of the individual that grew either in a folded position on its floor plate or over the surface of some host. After the death of the <i>Lichenocrinus</i> , <i>Corynotrypa inflata</i> (Hall) encrusted the upper and lower surfaces.	
9. <i>Lichenocrinus dubius</i> Miller.....	460
Two specimens attached to a nodule; they have grown down into the grooves. (989 W. M.) x 1.	

PLATE XXX.

FIGURE	PAGE
1—3. <i>Lichenocrinus dubius</i> Miller.....	464
1. Two specimens that are shown attached to a nodule on Plate XXIX, Fig. 9. This figure shows the crater plates and the isolated elevations. (989 W. M.)	
2. Another specimen showing the crater and body plates. (3875 U. C. M.)	
3. Holotype showing the character of the column and the irregularity of the basal body, only a few plates of which can be distinguished. (8783 W. M.)	
4—5. <i>Lichenocrinus stetteri</i> n. sp.....	466
4. Holotype showing the crater surrounded by the irregular, isolated elevations. (10007 C. L. F.)	
5. Enlargement of the same showing the large flat crater plates, the many irregular body plates and the isolated elevations.	
6. <i>Lichenocrinus pattersoni</i> Miller.....	461
Holotype showing the numerous irregular body plates and a portion of the column in place. (8842 W. M.)	
7—8. <i>Lichenocrinus fentonae</i> n. sp.....	462
7. One of the cotypes that is shown at the lower right hand side of Fig. 8. This shows the body plates arranged in concentric series. (10991 W. M.)	
8. A group of individuals, (cotypes), crowded together on a nodule. See Plate XXIX, Fig. 1. (10991 W. M.)	

PLATE XXXI.

FIGURE	PAGE
1—3. <i>Lichenocrinus schlemmeri</i> n. sp.-----	466
1—2. Two views of the same specimen showing several individuals attached to a crinoid column. (10006 C. L. F.)	
3. Holotype showing the shape of the basal body and the character of the plates. (10005 C. L. F.)	
4—5. <i>Lichenocrinus vaupeli</i> n. sp.-----	467
4. Holotype enlarged to show the large, ornamented body plates and the smooth crater plates. (10004 C. L. F.) x 5.	
5. Top view of the same showing that it is attached to a bryozoan. x 2.	
6—10. <i>Lichenocrinus twitchelli</i> n. sp.-----	463
6. A paratype showing the arrangement of the body plates. (10003 C. L. F.) x 5.	
7. A small individual with convex plates and pentagonal column. (10013 C. L. F.)	
8. A small individual attached to a bryozoan. (10002 C. L. F.)	
9. Showing the holotype attached to <i>Ceramoporella ohioensis</i> (Nicholson). The apparent overlapping of the plates is due to the collapse of the specimen. (10001 C. L. F.)	
10. Enlarged view of the same showing the nearly uniform size and other characters of the plates. x 4.75.	

PLATE XXXII.

FIGURE	PAGE
1—4. <i>Lichenocrinus kemperi</i> n. sp.-----	473
1. Top view showing the nearly uniform body plates and the deep crater. (10040 C. L. F.)	
2. Side view of the same showing the uniformly high convexity of the basal body.	
3. Top view of another specimen. (10041 C. L. F.)	
4. Side view of the same showing the convexity.	
5—12. <i>Lichenocrinus crateriformis</i> Hall-----	470
5. Cotypes, (not figured by Miller), of <i>L. affinis</i> Miller (8810 W. M.)	
6. Enlargement of the larger specimen shown in Fig. 5. This figure shows the large body plates arranged in series. x 5.	

FIGURE	PAGE
7. Top view showing the large crater with two rows of crater plates. (10044 C. L. F.) x 5.	
8. Top view of another specimen. (10045 C. L. F.)	
9. Top view showing clearly the character and arrangement of the plates. (W. H. S.) x 5.	
10. Hall's figure of <i>L. crateriformis</i> , presumably representing the specimen shown by Figs. 11 and 12.	
11. Hall's type of <i>L. crateriformis</i> . (1190 a A. M. N. H.) x 5.	
12. The same showing it attached to a <i>Strophomena</i> . x 1.	
13. <i>Lichenocrinus irregularis</i> n. sp.-----	473
Holotype showing the irregular body plates. (10046 C. L. F.) x 5.	

PLATE XXXIII.

FIGURE	PAGE
1—2. <i>Lichenocrinus tuberculatus</i> Miller-----	474
1. Top view of a specimen larger than the one shown in Fig. 2. This figure shows the high convexity of the basal body and the regular, highly convex to tuberculated body plates. (10031 C. L. F.)	
2. Miller's cotype and first figured specimen showing the high convexity of the basal body and the deep crater. (3877 U. C. M.)	
3—9. <i>Lichenocrinus milleri</i> n. sp.-----	476
3—5. Top, lateral and oblique views of the holotype showing the character of the plates, the deep crater and convexity of the basal body. (10029 C. L. F.)	
6. Top view of a paratype showing the irregular outline, the deep crater and the perforate column. (10021 C. L. F.)	
7. Top view of another specimen, attached to a <i>Hebertella</i> . This specimen is slightly weathered so the tubercles of the plates are not very distinct. (10030 C. L. F.)	
8. Top view of one of Miller's cotypes of <i>L. tuberculatus</i> . This specimen is highly convex and has tuberculated plates. The primary lamellae and the node can be seen in the central area. This specimen is attached to the irregular surface formed of branched bryozoans and <i>Zygospira</i> . (3878 U. C. M.)	
9. A section showing the floor plates with its node, the arrangement of the body and crater plates and the column resting on the latter. (100047 C. L. F.) x 3.5.	

FIGURE		PAGE
10—12.	<i>Lichenocrinus nodosus</i> n. sp.-----	477
10—11.	Lateral and top views of the holotype showing the large nodose plates, the elongate peripheral plates and the depth of the crater. (10032 C. L. F.)	
12.	Three cotypes showing the deep crater, the elongate crater plates, the nodose body plates and the large elongate marginal plates. (8826 W. M.)	

FIGURE	PLATE XXXIV.	PAGE
1—2.	<i>Lichenocrinus shideleri regularis</i> n. var.-----	479
1.	Top view of the holotype showing the regular, convex body plates arranged in circular series. (10027 C. L. F.)	
2.	Top view of a larger specimen that is not typical of this variety. (10025 C. L. F.)	
3—4.	<i>Lichenocrinus shideleri</i> n. sp.-----	478
3.	Top view of a paratype with an irregular outline and convex plates. (10028 C. L. F.)	
4.	Top view of the holotype showing the numerous tuberculated plates. (10026 C. L. F.)	
5—6.	<i>Lichenocrinus ashmanni</i> n. sp.-----	468
5.	Top view of the holotype showing the angular subquadrangular ridge and the pointed elevations on the plates forming it. (10016 C. L. F.)	
6.	Basal surface of the same showing the floor plate and the inferior surface of the series of heavy body plates forming the ridge of the opposite side.	
7—12.	<i>Lichenocrinus dyeri</i> Hall-----	469
7.	Hall's figure, presumably representing the specimen shown in Fig. 8.	
8.	Hall's type showing the irregularity of the body plates and the large column. (1190 A. M. N. H.) x 5.	
9.	Inferior surface of the body plates on which are traces of the lamellae. (10024 C. L. F.)	
10.	Section drawn from larger broken edge of specimen shown in Fig. 9. x 3.5.	
11.	Top view showing the numerous irregular plates and the large column. (34407 W. M.)	
12.	A small specimen attached to a <i>Rafinesquina</i> . (10023 C. L. F.) x 5.	

PLATE XXXV.

FIGURE	PAGE
1—3. <i>Xenobasis williamsi</i> n. sp.	480
1. Side view showing the general shape and the column composed of thin nodose plates which abut. (S. R. W.)	
2. Top view showing the general shape and the sub-pentagonal perforate column.	
3. An enlarged view showing the numerous polygonal body plates decerasing in size toward the rim and the minute polygonal plates between them. In some areas the small plates have been lost, thus giving the appearance of wide sutures. x 5.	
4—5. <i>Cystoidosaccus fultoni</i> n. sp.	482
4. Upper surface showing the general shape and the unequal subpolygonal plates. (10042 C. L. F.)	
5. Enlargement of the diamond-shaped opening seen near the lower margin of Fig. 4. x 4.75.	

THE SUPPOSED CALYX OF LICHENOCRINUS.¹

MILDRED ADAMS FENTON.

The name *Lichenocrinus* was proposed by Hall in 1866 for the problematic parasitic organisms so common in the Cincinnati and Richmond. At that time the exact nature of *Lichenocrinus* was not known as Hall considered the appendage homologous with the ventral tube of some crinoids; later, however, he believed it to be a column. In 1871 Meek suggested that the discs were peculiar attachments of some crinoid whose calyces had not been associated with the bases. C. L. Faber states² that, in 1898, he, G. Ashmann and A. Albers found complete specimens—base, column and calyx—in the Economy at Plaineville, Ohio; these specimens, unfortunately are lost so their exact nature is unknown.

Dr. G. M. Austin³ of Wilmington, Ohio, however, found also in 1898, specimens of *Lichenocrinus*⁴ associated with calyces in the Upper Blanchester, one-half mile up Cowan Creek from the Wilmington and Clarksville Pike, near Clarksville, Ohio. He concluded that the calyces (Plate XXXVI, Figs. 1-3) belonged to the basal attachments of *Lichenocrinus* with which they were associated, (Plate XXXVI, Figs. 5-7); this association he considered to be so close as to leave no doubt of the connection, even though no specimen was complete from base to calyx.

Let us now turn to a consideration of Dr. Austin's material that is here figured. There are eight specimens of *Lichenocrinus* attached to the surface of a rather coarsely striated *Rafinesquina*, (Plate XXXVI, Fig. 5), and three

¹ Contributions from the University of Cincinnati Museum. Geology and Paleontology. Number 9.

² This Journal, vol. 11, p. 455, 1929.

³ Austin Proc. U. S. Nat. Mus. No. 2671, vol. 70, art. 22, pp. 1-18, 1927.

⁴ Bassler, Bull. Geol. Soc. Am., vol. 39, No. 1, p. 298, 1928.

fragments of very delicate unmistakable *Lichenocrinus* column in the matrix beyond the margin of the shell. Attached to a fragment of *Isotelus*, (Plate XXXVI, Fig. 6), are four bases. On a bryozoan, (not figured), are two small, very poorly preserved bases. On still another piece of bryozoan, (Plate XXXVI, Fig. 7), are found six small bases and two fragments of *Lichenocrinus* column; several other fragments are found in the matrix beyond the bryozoan, the largest one can be seen to the right of the bryozoan in Figure 7.

A small calyx attached to a *Zygospira*, (Plate XXXVI, Fig. 3), is shown in what appears to be its original position in the slab, (Plate XXXVI, Fig. 7). If this is correct then the column lying on the bryozoan must have originally rested in the depression on the bryozoan and been attached to the calyx. The calyces, (Plate XXXVI, Figs. 1-3), do not have enough of the columns preserved to show their character.

The identification of the calyces, beyond their *Heterocrinoid* relationships, is impossible because the specimens are very small and the outlines of the plates can be seen in only a few cases. A calyx, (Plate XXXVI, Fig. 4), from the Black River at St. Paul, Minnesota, seems to be similar to those shown in Figures 1-3. Since the formation, Black River (Platteville), contains *Lichenocrinus* the probability that it represents this genus is increased.⁵ The bases (Plate XXXVI, Figs. 5-7) all appear to be of the same type; Dr. Austin states that they are *Lichenocrinus affinis* Miller which, according to C. L. Faber⁶, is a synonym of *L. crateriformis* Hall.

Thus the evidence at hand, together with Dr. Austin's account of their occurrence, leads one to consider that the calyces belong to the bases with which they are so closely associated since the only other crinoidal material noted was one columnal of *Heterocrinus juvenis* Hall, 5.8 mm. in diameter and therefore too large to belong to the calyces here considered.

⁵ This Journal, vol. 11, pp. 494-499, 1929.

⁶ This Journal, vol. 11, p. 470, 1929.

EXPLANATION OF PLATE XXXVI.

(Specimens in the U. S. Nat. Museum)

FIGURES

- 1—3. Calyces of a *Heterocrinoid* associated with *Lichenocrinus crateriformis*.
 - 1—2. Opposite sides of two different specimens. x 5.
 3. Another calyx attached to a *Zygospira*.
This is also shown in Fig. 7. x 5.
 4. A similar type of calyx from the Black River at St. Paul, Minn. (No. 42, 115.). x 5.
 5. Eight specimens of *Lichenocrinus* attached to a *Rafinesquina*. A fragment of *Lichenocrinus* column can be seen in the upper left hand corner (where the shell is broken); there are two fragments at the lower left, (these are so small they can scarcely be seen). x 1.
 6. Four specimens of *Lichenocrinus* attached to a fragment of *Isotelus*. x 2.
 7. Slab showing five specimens of *Lichenocrinus*, (a sixth is obscured), attached to a bryozoans. At the left center is the calyx shown in Fig. 3; this seems to have been its original position. Fragments of columns can be seen on the bryozoan and in the matrix to the right and lower left of it. x 2.
-

NOTES ON SEVERAL FORMS OF LICHENOCRINUS FROM BLACK RIVER FORMATIONS.¹

MILDRED ADAMS FENTON.

In comparing some specimens of *Lichenocrinus* from the Black River of the Mississippi Valley with others from the Cincinnati and Richmond some interesting relationships are noted. Several Black River forms appear to be ancestral to Richmond species while one is related to a Mt. Hope form. On the whole the specimens are much smaller than those from the Richmond and the characters are, therefore, less distinct. One specimen, here described as *L. ornatus*, is comparable in size to the average Cincinnati or Richmond forms and appears to be related to a Waynesville species. Comparisons are rendered difficult, however, by the fact that only a small number of the Black River specimens can be used as some are too small to show distinctive characters and others are so poorly preserved that their characters are lost. Additional *Lichenocrinus* material will, no doubt, show still other relationships of Black River and Richmond forms.

LICHENOCRINUS NODOSUS MINNESOTENSIS N. VAR.

Plate XXXVII, Fig. 1.

Description.—This form has a relatively high convexity with a wide deep crater. The plates immediately surrounding the delicate column are obscured by matrix but those on the crater slopes are comparatively large and are arranged in one circular series. The series of the body plates nearest the crater area are of about the same size as those within it; they are convex with low rounded elevations and a few bear incised lines paralleling the margins; the plates at the periphery are larger and very irregular in outline. A few small plates appear between these two series.

¹ Contributions from the University of Cincinnati Museum. Geology and Paleontology. Number 10.

The dimensions of the holotype are: diameter 4 mm.; diameter of the crater 1.5 mm.; diameter of the column 0.5 mm.

Remarks.—This form, characterized by large peripheral plates, seems to be related to *L. nodosus*² C. L. Faber, from which it differs in the lack of the elongate crater plates and pronounced nodose body plates. Though these latter are important characters of *L. nodosus* a relationship between the two forms seems to be indicated by the elongate peripheral plates. A larger specimen might show an even closer relationship.

Occurrence.—Black River, St. Paul, Minnesota.

Holotype.—U. S. N. M.

LICHENOCRINUS NODOSUS AFF. MINNESOTENSIS N. VAR.

Plate XXXVII, Figs. 2-3.

Remarks.—The two specimens shown in Figures 2 and 3 are small and do not have their plates clearly demarked. The former, Plate XXXVII, Fig. 2, is from the same locality as the holotype of *L. nodosus minnesotensis*, and while it does not appear to be identical with that form, it certainly shows a close relationship. The other specimen, Plate XXXVII, Fig. 3, is distorted in growth but shows a few large plates near the margin.

Occurrence.—The specimen shown in Figure 3 is from the Beloit at Minneapolis, Minnesota, and the other specimen may be from the same horizon. It is from St. Paul, Minnesota.

Figured specimens.—U. S. N. M.; No. 881, U. C. M.

LICHENOCRINUS AUSTINI N. SP.

Plate XXXVII, Fig. 4.

Description.—All the plates of this specimen appear to be of approximately uniform size; some are convex and others

² This Journal, vol. 11, p. 477, 1929.

are flat, though this is probably a result of weathering. The column is entirely broken away. The diameter is 7 mm.

Remarks.—Though this specimen is not well preserved its characters appear to be distinct.

Occurrence.—Black River, St. Paul, Minnesota.

Holotype.—U. S. N. M.

LICHENOCRINUS AFF. CRATERIFORMIS HALL.

Plate XXXVII, Figs. 5-8.

Remarks.—The specimens here considered are closely related to *Lichenocrinus crateriformis* Hall, from the Richmond. Of the four figured specimens, two are from Dixon, Illinois, one from Cannon Falls, Minnesota, and the fourth from Minneapolis, Minnesota; their respective maximum diameters are: 5.6, 3.8, 5 and 6 mm. These are approximately the same size as average specimens of *L. crateriformis*. While these Black River forms do not have such pronounced craters nor such clearly demarked plates their general character is similar to that of *L. crateriformis*.

Occurrence.—Black River; specimens from Dixon, Illinois, Cannon Falls and Minneapolis, Minnesota.

Figured specimens.—U. S. N. M.; (one shown on Plate XXXVII, Fig. 7) No. 875 U. C. M.

LICHENOCRINUS ORNATUS N. SP.

Plate XXXVII, Fig. 9.

Description.—The crater is small and only moderately deep, about a third of it is occupied by a quinquepartite column, a small portion of which is in place. The plates immediately around the column are indistinct; one circular series of plates alternating with the body plates forms the wall of the crater. These plates usually have three sides peripherally and the other portion of the plates that turn downward to form the wall of the crater are not clearly demarked. The large body plates (two to three circular series) are irregularly polygonal with from four to eight angles; they range in diam-

etre from 1.3 to 2 mm. and have their maximum diameter along the radii of the specimen. Each of these plates bears a low rounded elevation and deeply incised lines paralleling the margins; the latter probably represent successive growth stages. Between these ornate plates and the margin are small polygonal plates of the same general character as the large ones but less ornamented; a few plates have a pronounced convexity and others bear incised lines. The irregular outline of this specimen is due to the irregular arrangement of these marginal plates.

Measurements: maximum diameter 9.3 mm.; diameter of the crater 2.7 mm.; diameter of the column 1 mm.

Remarks.—*Lichenocrinus ornatus* resembles *L. milleri*³ C. L. Faber in general appearance. The former lacks, however, the highly tuberculated body plates and seems to have a larger proportion of small plates near the periphery. *L. ornatus* is smaller than *L. milleri*, though of course this is unimportant.

Occurrence.—Black River, Kirkfield, Ontario.

Holotype.—U. S. N. M.

LICHENOCRINUS SPP.

Plate XXXVII, Figs. 10-11.

Remarks.—The specimen shown in Figure 10 is completely collapsed with the plates resting directly on the host. The plates are convex and approximately uniform in size. The column and plates surrounding it are lost. The characters are therefore too indistinct to permit identification. The group of specimens shown in Figure 11 are very small. Their plates are convex and show a few incised lines paralleling the margin. The relationships of these forms are uncertain; they might possibly be related to *Lichenocrinus ornatus* but the characters due to the small size of the specimens are too indefinite to warrant certain identification.

Occurrence.—Decorah near Rochester, Minnesota.

Figured specimens.—Nos. 600 and 669, U. C. M.

³ This Journal, vol. 11, p. 476, 1929.

LICHENOCRINUS AFF. ASHMANNI C. L. FABER.

Plate XXXVII, Fig. 12.

Lichenocrinus ashmanni Faber, Am. Mid. Nat., vol. 11, p. 468, pl. 34, fig. 5, 1929.

Description.—One specimen closely resembles the holotype of *L. ashmanni* C. L. Faber in general appearance though it is somewhat smaller. It has a pronounced irregular ridge though not as sharp as that of *L. ashmanni*. The plates surrounding the column are large and flat and are arranged in one to two circular series. The plates forming the ridge are slightly larger than the crater plates and in forming the crest have portions sloping toward the crater and toward the margin. A few of these plates have low rounded elevations in the center. The plates from the ridge to the margin are flat or convex and have no definite arrangement.

Dimensions: maximum diameter 7.4 mm.; diameter of the crater 3-4 mm.; diameter of the base of the column 1.5 mm.

Remarks.—Though the specimen under consideration is from the Decorah and *L. ashmanni* is from the Mt. Hope the close similarity does not seem to warrant a separation, at least until more and better material is found.

Occurrence.—Decorah formation of the Black River, Fountain, Minnesota.

Figured specimen.—No. 599 U. C. M.

EXPLANATION OF PLATE XXXVII.

(NOTE: U. S. N. M.—U. S. National Museum; U. C. M.—University of Cincinnati Museum. Figures x2 unless otherwise stated.)

FIGURES	PAGE
1. <i>Lichenocrinus nodosus minnesotensis</i> n. var.	494
The holotype showing the relatively large plates near the periphery. (U. S. N. M.)	
2—3. <i>Lichenocrinus nodosus</i> aff. <i>minnesotensis</i> n. var.	495
2. A small specimen with plates not clearly demarked. From the same locality as the holotype. (U. S. N. M.)	
3. A specimen distorted in growth. It is similar to the one shown in Fig. 2 and like it is provisionally placed in this variety. (881 U. C. M.)	
4. <i>Lichenocrinus austini</i> n. sp.	495
The holotype showing the uniform plates. (U. S. N. M.)	
5—8. <i>Lichenocrinus</i> aff. <i>crateriformis</i> Hall.	496
5—6. Two specimens closely related to <i>L. crateriformis</i> Hall. (U. S. N. M.)	
7. Another specimen closely related to <i>L. crateriformis</i> ; the wide, flat crater is typical of that species. (875 U. C. M.)	
8. A specimen with a small deep crater and small column; it is here considered with forms related to <i>L. crateriformis</i> . (U. S. N. M.)	
9. <i>Lichenocrinus ornatus</i> n. sp.	496
The holotype showing the large body plates marked by incised lines and low rounded elevations. Numerous small plates can be seen near the periphery. (U. S. N. M.)	
10. <i>Lichenocrinus</i> sp.	497
A specimen from the Decorah; it is flattened and some of the plates are lost. (600 U. C. M.) x 5.	
11. <i>Lichenocrinus</i> sp.	497
Several specimens also from the Decorah; these are too small to show clearly their characters. (669 U. C. M.) x 5.	
12. <i>Lichenocrinus</i> aff. <i>ashmanni</i> C. L. Faber.	498
A form from the Black River showing a close relationship to the Mt. Hope form of <i>L. ashmanni</i> . (599 U. C. M.)	

STROPHOMENA FILITEXTA HALL, A VALID SPECIES.¹

CARROLL LANE FENTON.

In a recent paper describing "Forms of *Strophomena* from Black River and Richmond Formations,"² I discussed the supposed equivalence of *Strophomena incurvata* (Shepard) and *S. filitexta* Hall. The conclusion reached was that *S. incurvata*, never having been described adequately from the original material, must be abandoned; and that in lieu of adequate redescription, *S. filitexta* must suffer like fate.

There is mention, also, of the lack of types: "Although the types were supposed to be in the American Museum of Natural History, Dr. Reeds writes me that they are lost."³ This is an unfortunate over-statement of the case: Dr. Reeds' actual words were "we do not seem to have the types of *Strophomena filitexta* figured by Hall in Volume I of the *Paleontology of New York*, which you requested. Hall called this species *Leptaena filitexta* . . . and all of the types that we have of that species refer to Volume VIII and not Volume I of the *Paleontology of New York*." Dr. Reeds has kindly called my attention to my error concerning the earlier types, at the same time announcing that another search has discovered them. Through his kindness the specimens have been loaned for study and description. There seems no doubt that they represent a distinct species, and as such they are here described.

¹ Contributions from the University of Cincinnati Museum. Geology and Paleontology. Number 11.

² This Journal, vol. 11, pp. 144-159, 1928.

³ This Journal, vol. 11, p. 147, 1928.

STROPHOMENA FILITEXTA HALL.

Plate XXXVIII, Figs. 1-5.

Leptaena filitexta Hall, Pal. N. Y., vol. I, p. 111, pl. 31 B, fig. 3 a-f. 1847.

Strophomena filitexta Hall and Clarke, Pal. N. Y., vol. 8, pt. 1, p. 251, pl. 9, fig. 6. 1892.

Description.—Shell large, thin to moderately thick. Dimensions of two specimens: length 31.5 and 30 mm.; width 47.5 and 44.8 mm.; thickness 11 and 4.5 mm. One pedicle valve has a thickness of about 10 mm.

Pedicle valve flattened umbonally except at the beak which projects rather sharply. Cardinal area wide and high, deltidium prominent. Muscular area large, elevated; teeth prominent. The muscular area is divided into two lobes by a broad, low septum which originates near the beak and bears the linear adductor scars. Diductor scars striate, sharply pointed and elevated anteriorly. The intramarginal thickening is crossed by straight, narrow vascular sinuses, and the surface is finely tuberculate.

Brachial valve flat umbonally, convex medially and flattened again anteriorly. The extremities are recurved, but in none of the specimens at hand are they crenulate. The surface is marked by rounded costae which increase by implantation; over most of the shell there is pronounced alternation, every fourth to eighth costa being larger than the rest. The costae are crossed by closely spaced, concentric wrinkles, as shown in Figures 4-5.

Remarks.—Although distinct from any other form of *Strophomena*, *S. filitexta* is closely related to *S. auburnensis* of the Auburn formation of Missouri and *S. plattinensis*; and anyone who gives the term species great latitude would be justified in reducing these latter to subspecies. A more satisfactory procedure, however, is to associate them in a single

gens, which may well take its name from *S. filitexta*—the *Strophomena filitexta* gens.⁴

It may be commented, also, that the types of *S. filitexta* represent two slightly differing forms, from apparently different strata. The unquestioned cotypes (Figures 1 and 2) belong to the typical black Trenton limestone; the costae are coarse and anteriorly not distinctly alternating. Those of Figures 3-5 may be plesiotypes only, since neither is figured in Volume I of the Paleontology of New York, and only one in Volume VIII. Their matrix is a brownish, oxidized limestone though where partly exfoliated the fossil itself appears to be black. Differences in costae have been mentioned; those in the character of the muscular area may be seen by comparing Figures 2 and 3.

Because of these discrepancies among the type specimens, it seems necessary that one of them be designated as the specimen on which this redetermination of *Strophomena filitexta* is based. Hall's original description indicates that this should be the complete shell illustrated by Figure 1 of Plate XXXVIII. Unfortunately, that specimen furnishes no really diagnostic characters and adoption of it as a lecto-holotype would mean that future identifications of the species could not be made. The pedicle valve shown in Figure 2, on the other hand, shows characters which are diagnostic, and which can be recognized even in Hall's original figure. For this reason, chief reliance is placed upon it, though it hardly can be selected as a lecto-holotype.

⁴ The term gens is one which deserves more frequent use than has been given it in American paleozoology. It was proposed by Vaughn (Quart. Journ. Geol. Soc., vol. 61, p. 183, 1905) to include "the aggregate of all the species which possess, in common, a large number of essential properties, and are continuously related either in space or time." As Bather remarks (Quart. Journ. Geol. Soc., vol. 83, p. lxxxviii, 1929) the gens is thus synonymous with the less convenient term "collective species" (Collectivart) of Waagen, and fits excellently such cases as *Strophomena filitexta* and its relatives. It has been employed in similar instances by Williams (U. S. Geol. Surv., Prof. Paper 79, pp. 53, 77-79, 1913.)

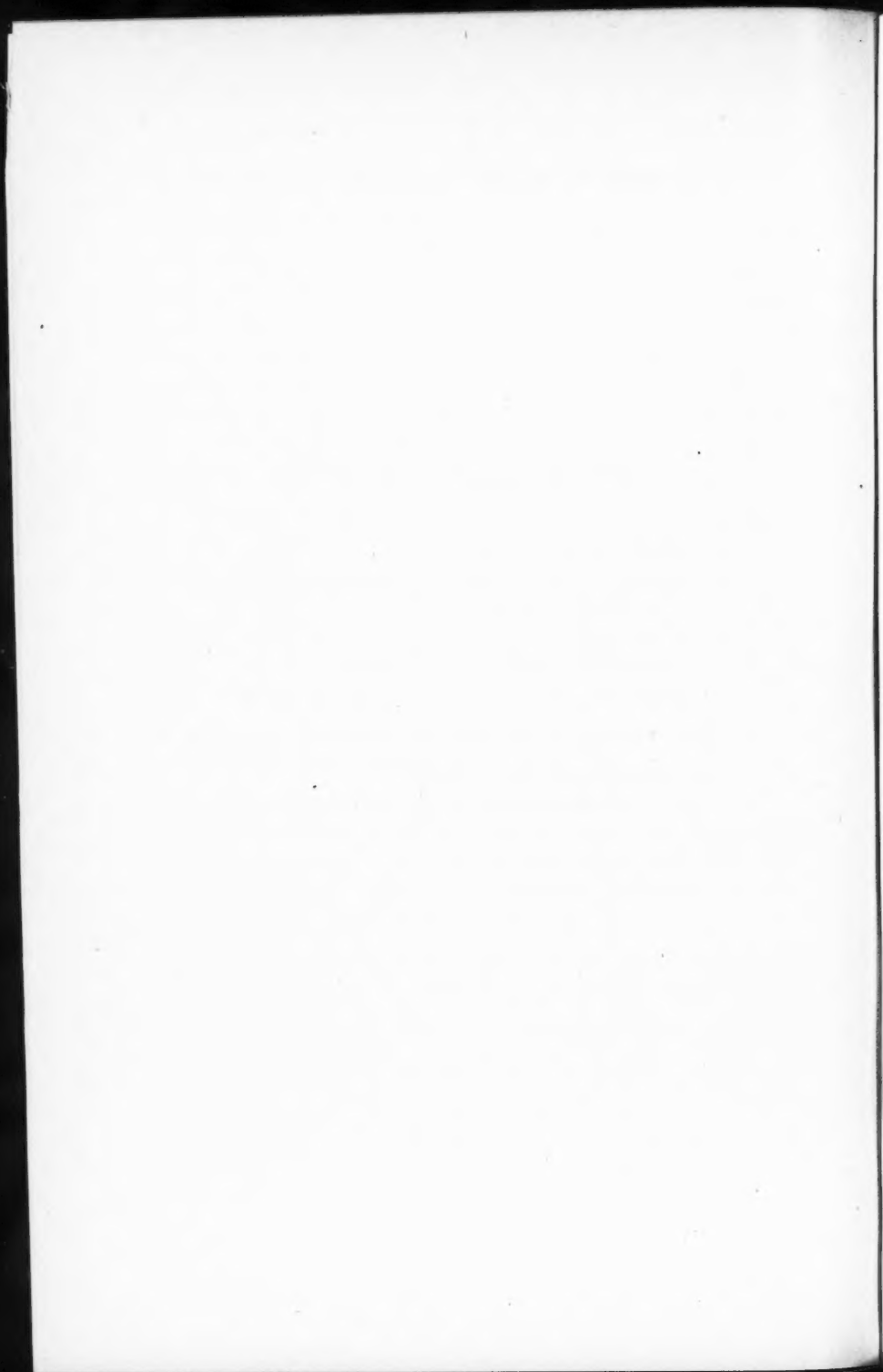
EXPLANATION OF PLATE XXXVIII.

FIGURE

1—5. *Strophomena filitexta* Hall.

1. Brachial view of the cotype to which the original description most clearly refers.
2. Internal view of a pedicle valve, showing diagnostic characters relied upon in this description.
3. Internal view of a second pedicle valve, not typical.
- 4—5. Enlargements of the surface of a brachial valve, x 10.
In Figure 4, the strips of paper mark the portion illustrated by Hall and Clarke.

(All specimens, No. 702 A. M. N. H.)



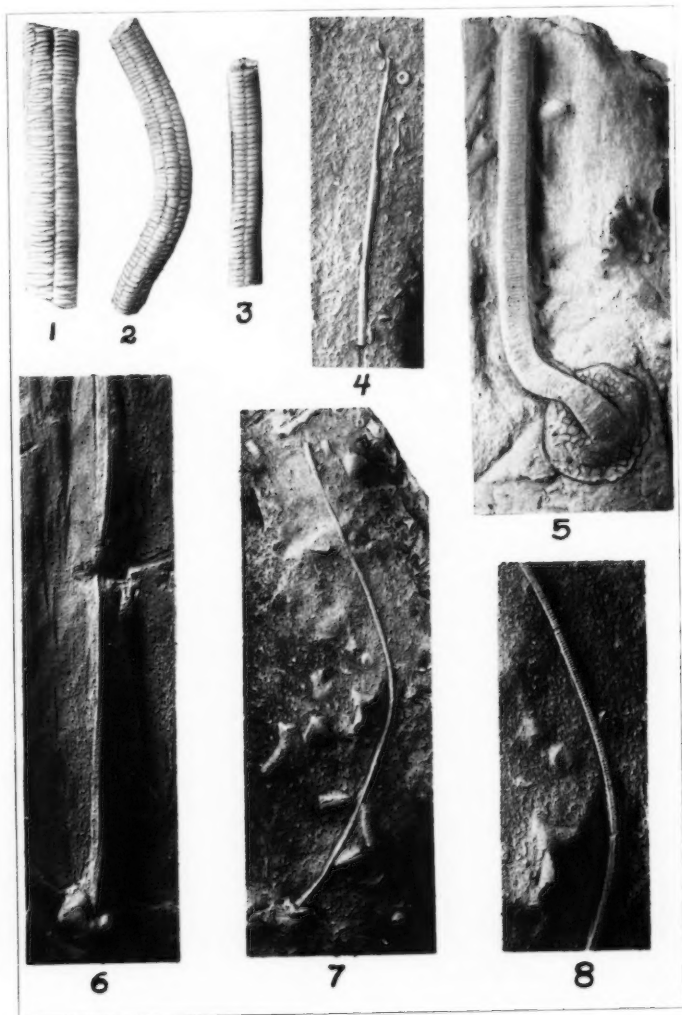


Plate XXVII

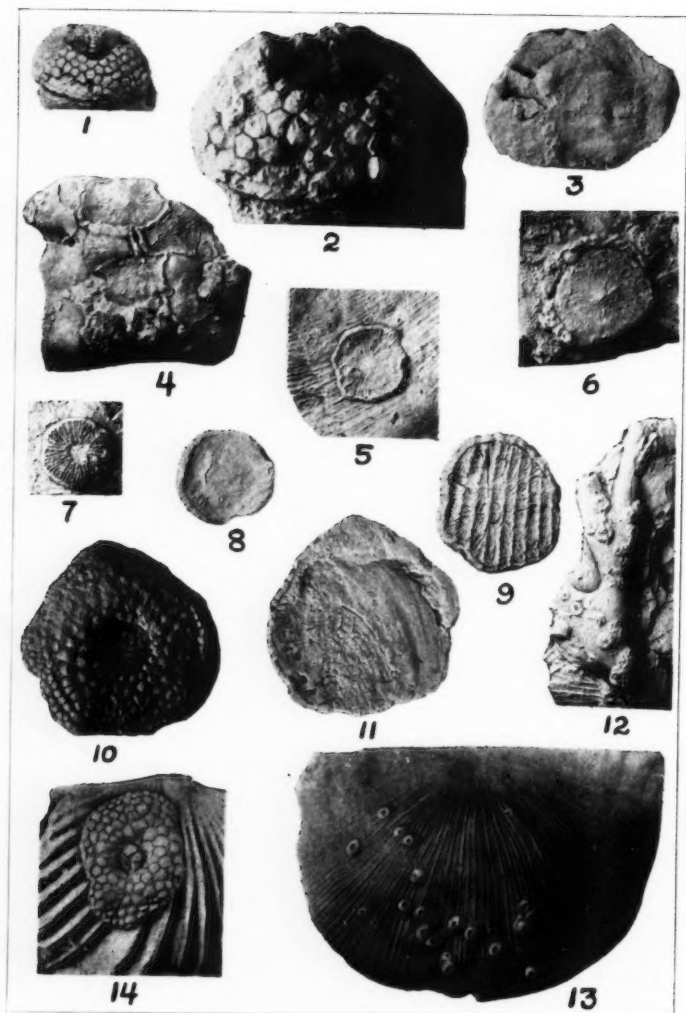


Plate XXVIII

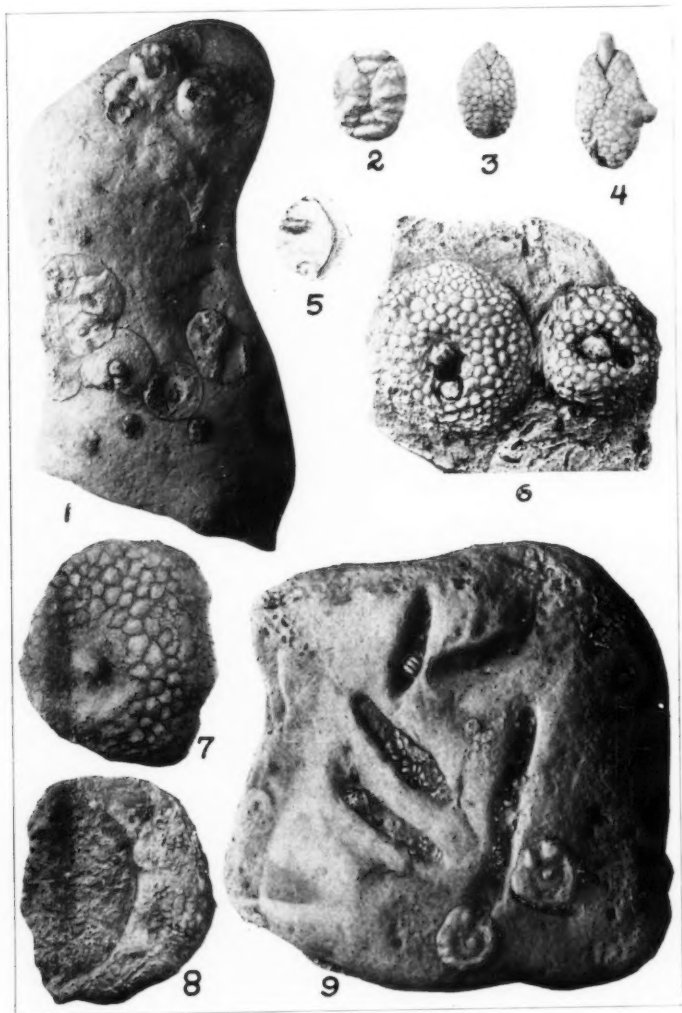


Plate XXIX

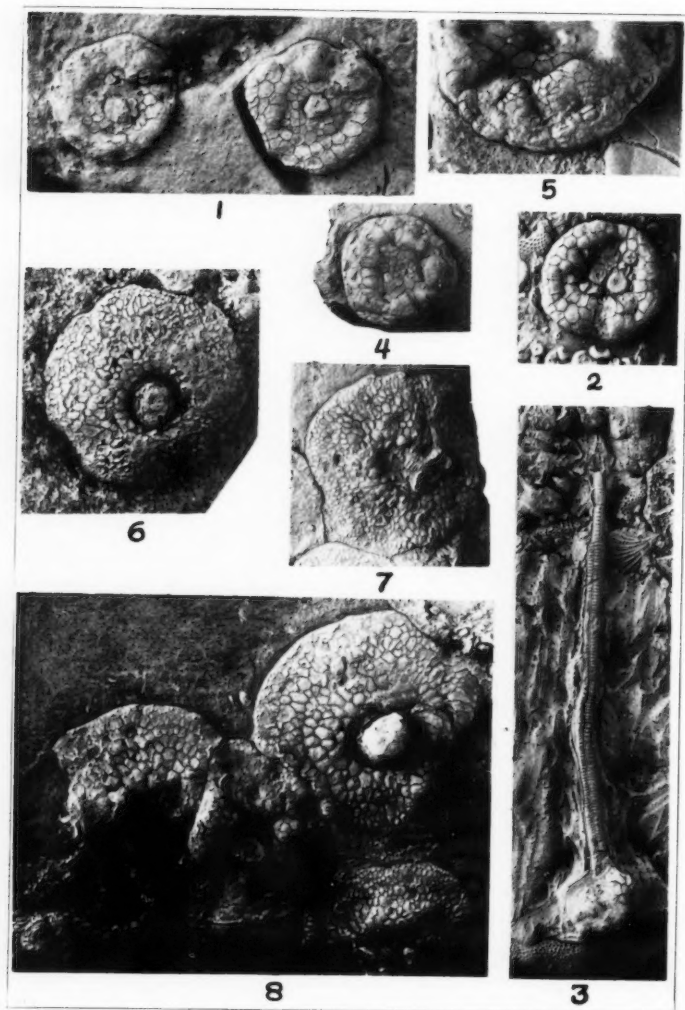


Plate XXX

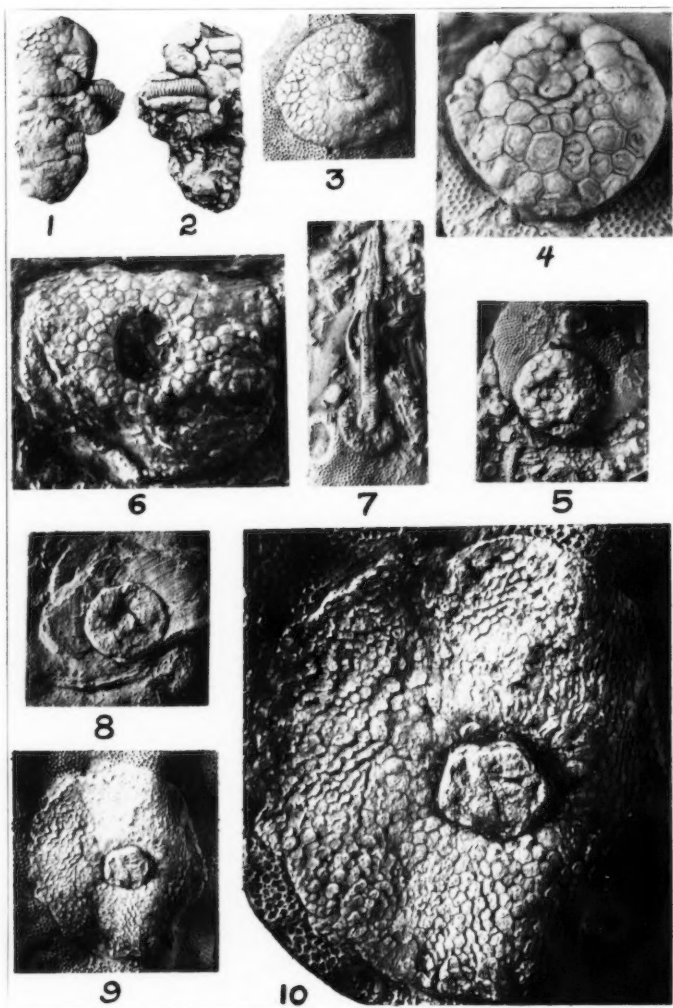


Plate XXXI

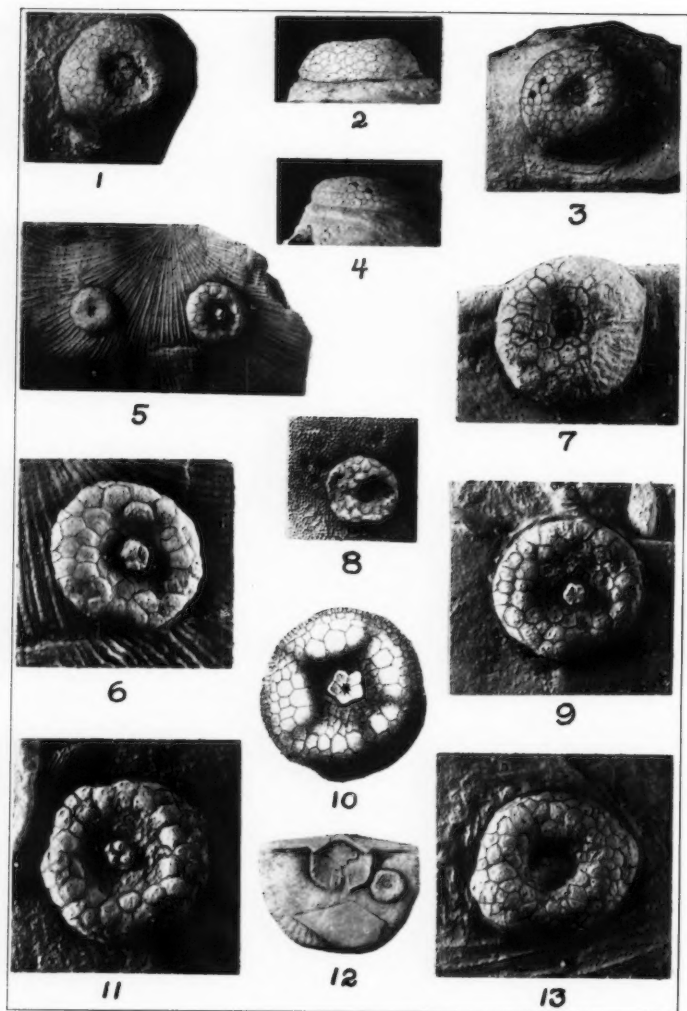


Plate XXXII

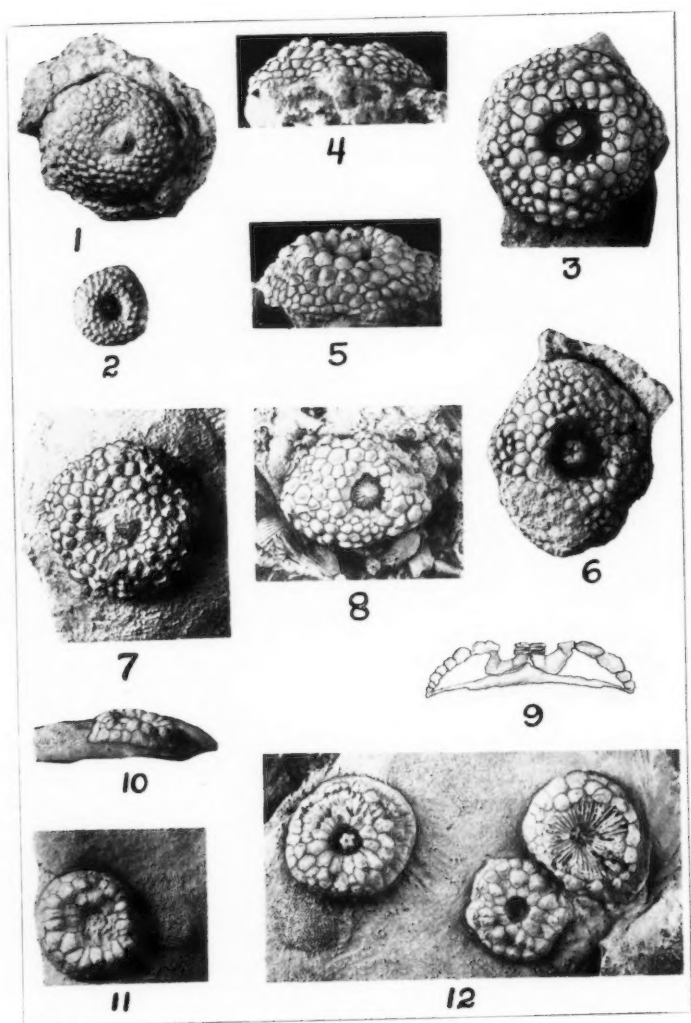


Plate XXXIII

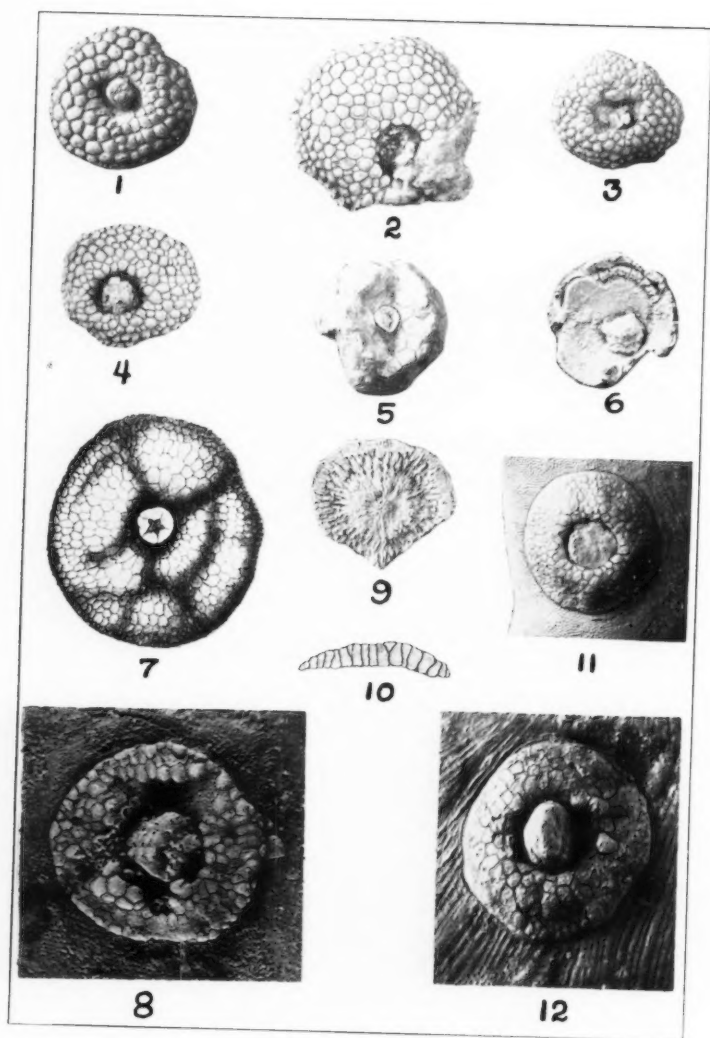


Plate XXXIV

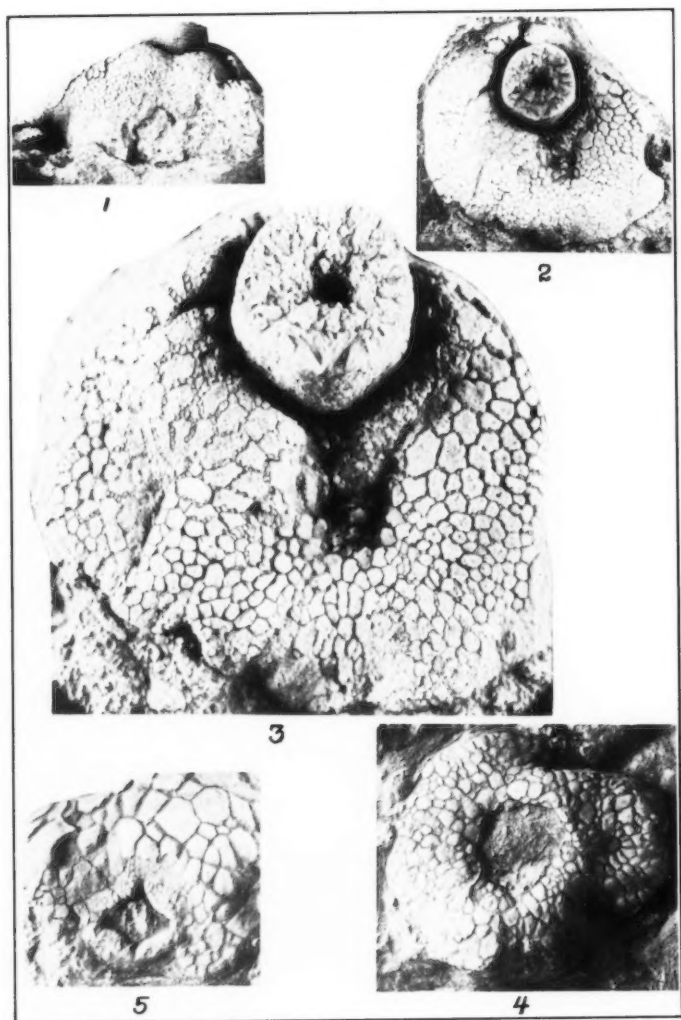


Plate XXXV

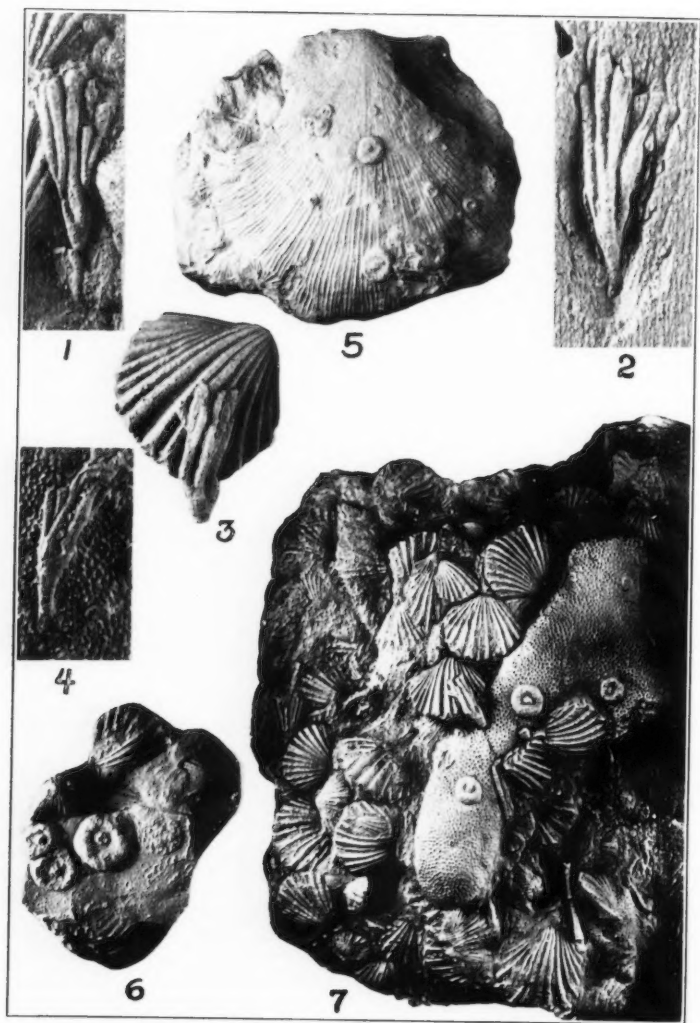


Plate XXXVI

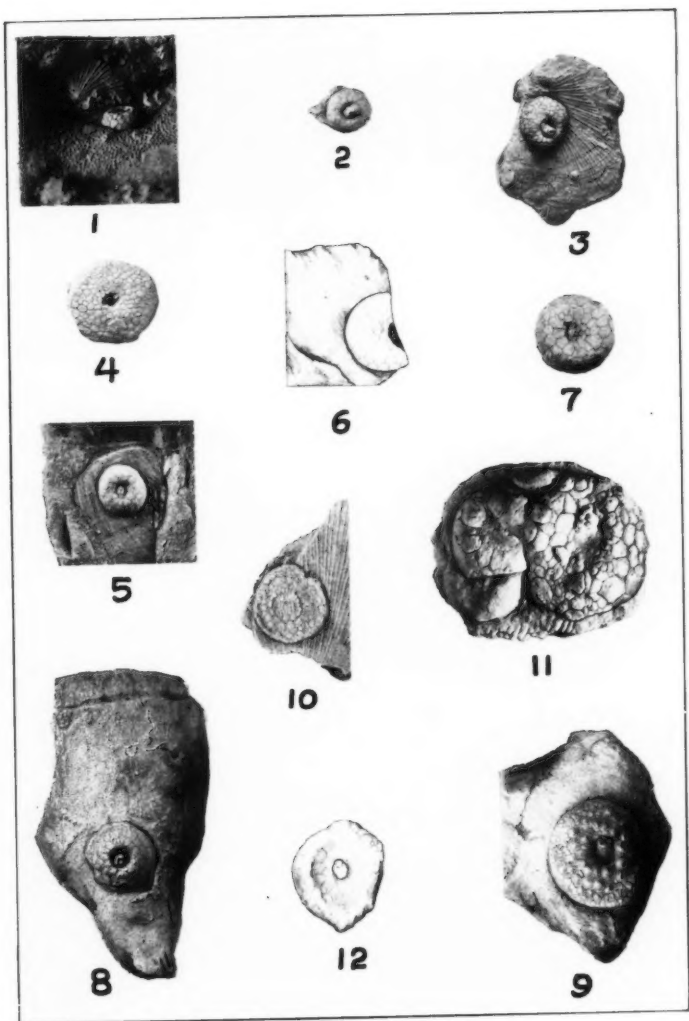


Plate XXXVII

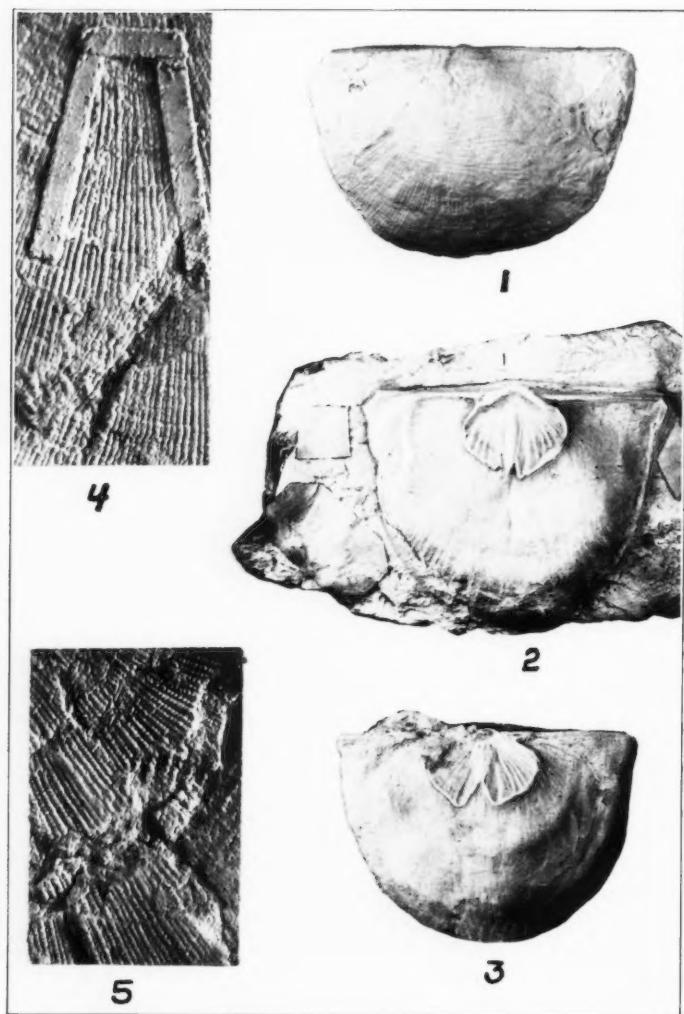


Plate XXXVIII

NOTE

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